QK
T69
Bot

Vol. 79 MAY-JUNE, 1952 No. 3

UNIVERSITY OF MICHIGAN
MAY 15 1952
SCIENCE LIBRARY

Bulletin

of the

Torrey Botanical Club

CONTENTS

The Effects of Maleic Hydrazide on Growth and Cell Division in Pisum sativum ..... *Winifred Compton* 205

Uredinales from Various Regions ..... *George B. Cummins* 212

Retardation in Cell Development in Leaf and Flower Buds of Phaseolus vulgaris L. from Foliar Application of Maleic Hydrazide ..... *Donald P. Watson* 226

Inhibition and Enhancement of the Growth of Fungi with Streptomycin ..... *John B. Loefer, F. W. Bioberdorf and R. G. Weichlein* 242

Studies on the Lichen Rinodina oreina in North America *Mason E. Hale, Jr.* 251

Torreya

Additive and Inhibitive Effects Resulting from Treatment of Tomato Seedlings with Indoleacetic Acid in Combination with 2,4-Dichlorophenoxyacetic Acid. By *A. E. Hitchcock*. Proceedings of the Club. Book Reviews. Notes. Floral Eponyms. 260

Index to American Botanical Literature 273

Published for the Club bi-monthly

by

THE BUSINESS PRESS, INC.
N. QUEEN ST. AND McGOVERN AVE.
LANCASTER, PENNSYLVANIA

THE TORREY BOTANICAL CLUB

Officers for 1952

President: M. A. Johnson

Vice-presidents: M. F. Buell, L. M. Black

Treasurer: Elva Lawton

Editor: Charles A. Berger

Recording Secretary: Donald P. Rogers

Business Manager: Sophie Jakowska

Corresponding Secretary: Jennie L. S. Simpson

Bibliographer: Mrs. Lazella Schwarten

The Bulletin of the Torrey Botanical Club

Editor

Charles A. Berger

Associate Editors

Irving W. Bailey
Stanley A. Cain
Adriance S. Foster
Barbara McClintock
Murray F. Buell
Edwin B. Matzke
Wendell H. Camp
Donald P. Rogers
H. W. Rickett
Frederick Kavanagh

John A. Small (Torreya)

Membership dues should be sent to Dr. Elva Lawton, Hunter College New York 21, N. Y. Subscriptions and correspondence about advertisements and back numbers should be addressed to Dr. Sophie Jakowska, College of Mt. St. Vincent, New York 71, N. Y. Communications about exchanges should be sent to Dr. Jennie L. S. Simpson, Hunter College, New York 21, N. Y. Manuscripts intended for the Bulletin should be sent to Dr. C. A. Berger, Biological Laboratory, Fordham University, New York 58, N. Y. Material for Torreya should be sent to Dr. John A. Small, New Jersey College for Women, New Brunswick, N. J.

Claims for missing numbers must be made within 60 days from the date of issue.

The subscription price of the Bulletin of the Torrey Botanical Club (including Torreya), is $9.00 a year except to active members of the Club. The annual membership dues covers a year's subscription to the Bulletin.

Entered as second-class matter October 8, 1940 at the post office at Lancaster, Pa., under the Act of March 3, 1879. Accepted for mailing at the special rate of postage provided for in the Act of February 28, 1925, embodied in Paragraph (d-2) Section 34.40 P. L. & R. of 1948.

BULLETIN OF THE TORREY BOTANICAL CLUB
VOL. 79, NO. 3, PP. 205–211 MAY, 1952

THE EFFECTS OF MALEIC HYDRAZIDE ON GROWTH AND CELL DIVISION IN PISUM SATIVUM[1]

WINIFRED COMPTON

Schoene and Hoffman (1949), conducting preliminary experiments with maleic hydrazide (MH), found that the chemical has "a pronounced, but temporary inhibiting effect on plant growth." Later experiments resulting in the publication of more than fifty reports have confirmed and extended these results. Maleic hydrazide appears to inhibit growth of most species of seed plants which have been treated, but Currier and Crafts (1950) have shown that various species of plants react differently to the compound. Usually after varying periods of time, treated plants resume growth, but often plants live for months after treatment without further growth. When growth is resumed, it usually occurs from lateral buds rather than the inhibited terminal buds.

To determine whether inhibition of growth is due to a reduction in cell division and/or cell elongation, Greulach and Atchison (1950) placed bulbs of Southport Yellow Globe onions in MH of concentrations of 1, 10, 100, 1000 ppm. (parts per million) for varying periods of time. They reported: "Effects on both (cell division and elongation) were in order of the concentrations of the MH solutions, but the effects on cell division did not occur simultaneously with the effect on total growth." It was suggested that the lower concentrations inhibit cell division but not cell enlargement while higher concentrations inhibit both. Darlington and McLeish (1951) found that MH inhibited cell division in several species of plants.

The present problem was undertaken to determine the comparative effects of maleic hydrazide on mitosis and cell elongation in the root and shoot tips of *Pisum sativum;* and to observe its effects on total growth in relation to its effects on cell division and elongation.

Materials and methods. Seeds of *Pisum sativum* L. (var. Early Alaska) were soaked in distilled water for three hours and the seed coats were removed.

The seeds were divided into seven groups, one of which was soaked in distilled water for twelve hours and used at a control. Each of the other groups was soaked for the same period of time in one of the following con-

[1] This paper is the result of research done in partial fulfillment of the requirements for the degree of Master of Arts in the department of Botany at the University of North Carolina, Chapel Hill, N. C.

The writer wishes to express her gratitude to Dr. Earlene Atchison under whose guidance the work was done. Appreciation is expressed to Dr. V. A. Greulach for reading and criticizing the manuscript.

[THE BULLETIN for March–April (79: 107–204) was issued February 25, 1952]

centrations of the diethanolamine salt of maleic hydrazide (MH 30) : 10, 50, 100, 300, 500, 1000 ppm. The seeds were then washed in distilled water and transferred to clean containers lined with moistened filter paper. The dishes were placed in a darkened locker cabinet and the seeds allowed to germinate.

Measurements of the seedlings were taken at 24 hour intervals for a period of a week. Ten plants from each group were measured, and the average was used as an index to the total length of the seedlings within that group. No attempts were made to differentiate between the length of root and stem.

After fixation in Carnoy's fluid, the stipules were removed and the shoot tips were smeared in propio-orcein. Four slides were made from the control and all treatments at 24, 48, 72, and 96 hour intervals and also of the control, 300, and 1000 ppm. groups 144 and 168 hours after treatment. At least 250 cells were examined from each of the four slides and the number of dividing cells included in these microscopic fields was noted.

After fixation in Randolph's modified Navashin fluid, the root tips were stained by the Feulgen method, embedded in paraffin, and sectioned at 14 microns. Serial sections were made of the root tips from the control and all treatments at the 24, 48, 72, and 96 hour intervals and of the control, 300, and 1000 ppm. treatments at the 144 and 168 hour intervals. From each tip, examinations were made of three sections using every fourth section of the serial.

After seven days, the seedlings were planted in a mixture of soil and vermiculite and transferred to the greenhouse where they were under observation for a month.

Results. The control plants increased in size throughout the experiment, but the increase was not in a regular pattern. Mitotic figures were abundant.

The plants treated with 10 ppm. MH maintained approximately the same increase in length per day as the controls. The number of division figures was irregular, increasing and decreasing as did that of the controls. At the end of the four weeks growing period, these plants were somewhat shorter than the control plants. The mean length of the controls was 56 cm. as compared to 45 cm. for the 10 ppm. group.

The mean height of the plants treated with 50 ppm. MH was slightly less than the control on the first and third days of the experiment, but was greater than that of the control when the experiment was concluded (fig. 1). The number of cell divisions was considerably lower than the number of divisions in the control the first day, and although the number of divisions at most periods continued to be lower in the 50 ppm. group than in the control, the number increased with increase in time after treatment (fig. 2). The only period at which division figures were more abundant in the 50 ppm. MH than in the control was at the 72 hour interval (fig. 2, B).

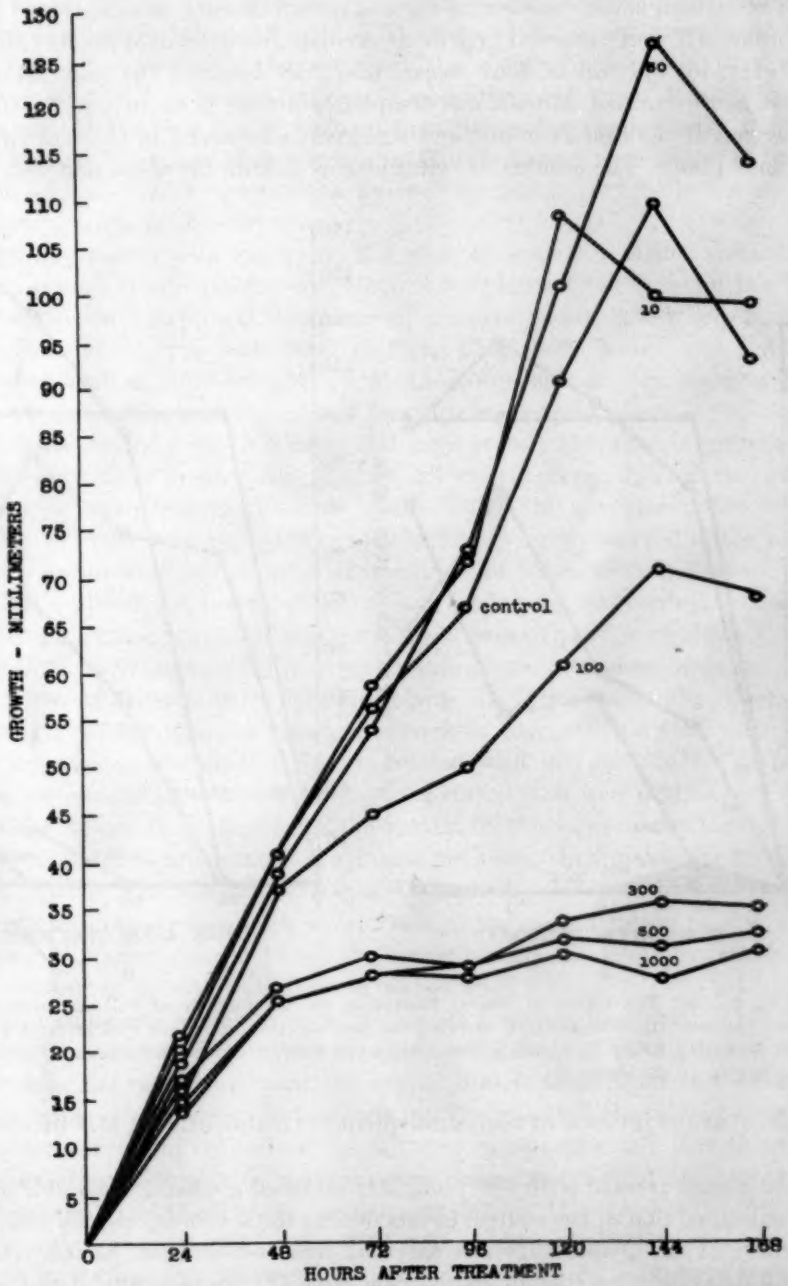


FIG. 1. The effect of maleic hydrazide on total length of *Pisum sativum*. Numbers on curves give concentration of MH in parts per million.

Throughout seven consecutive days of measurements, plants treated with 100 ppm. MH were retarded in growth as compared to control plants (fig. 1). However, by the end of four weeks, they had attained the same average height as the control. Mitosis was completely absent in shoot tips examined at the end of the first 24 hours, and was greatly retarded in the root tips of the same plants. The number of cell divisions in both the shoot and root tips

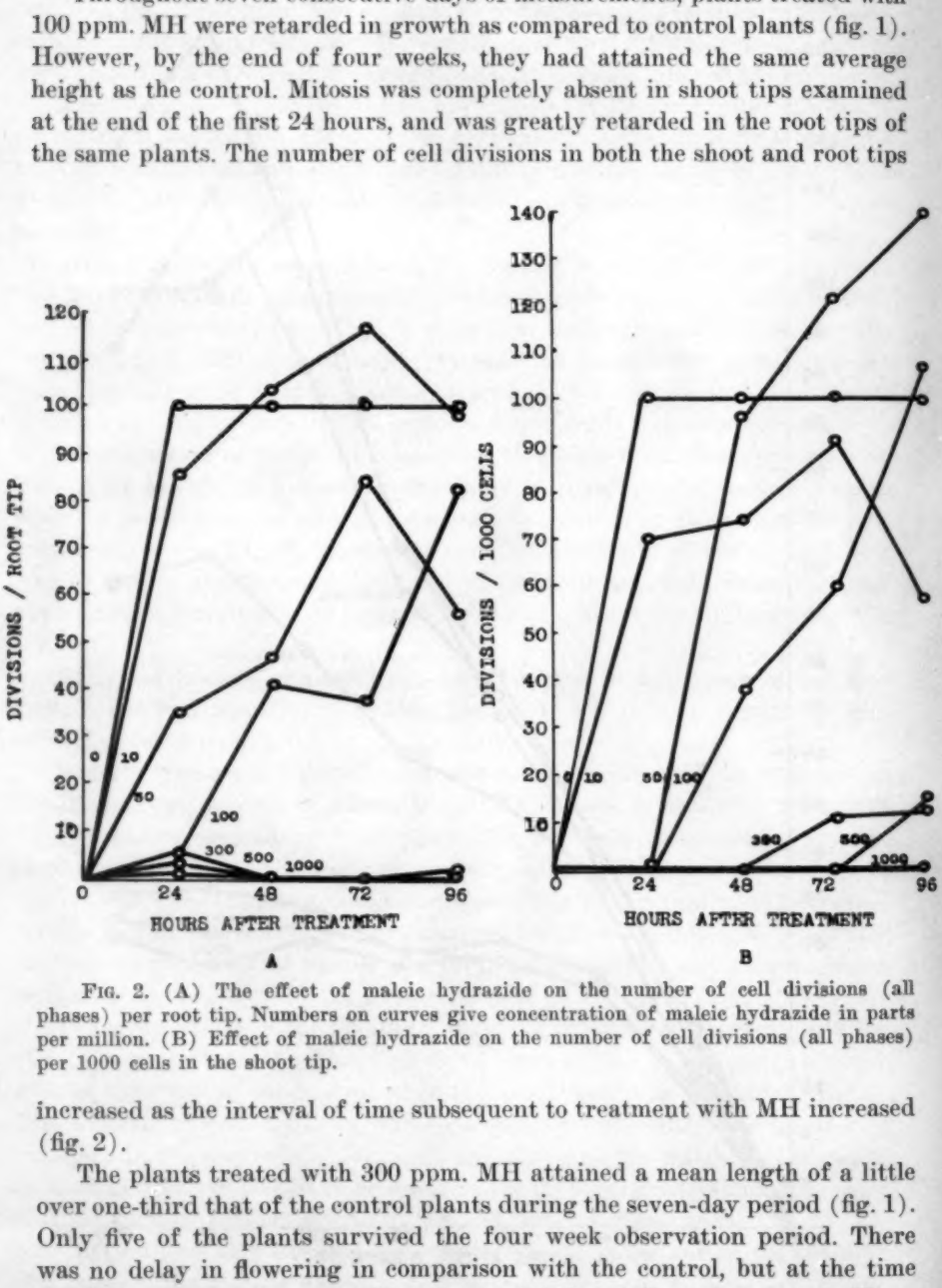


FIG. 2. (A) The effect of maleic hydrazide on the number of cell divisions (all phases) per root tip. Numbers on curves give concentration of maleic hydrazide in parts per million. (B) Effect of maleic hydrazide on the number of cell divisions (all phases) per 1000 cells in the shoot tip.

increased as the interval of time subsequent to treatment with MH increased (fig. 2).

The plants treated with 300 ppm. MH attained a mean length of a little over one-third that of the control plants during the seven-day period (fig. 1). Only five of the plants survived the four week observation period. There was no delay in flowering in comparison with the control, but at the time the 300 ppm. plants were still only one-third as tall as the control. There

were no secondary roots and the main root was definitely stunted and was of the same diameter at all points. The tips of the roots were blunt and rounded. This condition characterized the roots of all plants that were treated with MH in concentrations of and above 300 ppm. Mitotic figures were seen in the root tips of 24 hour material and again in material taken 96, 144, and 168 hours after treatment. Mitotic figures were observed in the shoot tips after 72 hours but the number increased very little during the remaining periods (fig. 2).

Plants treated with 500 ppm. MH were noticeably retarded during the entire period of the experiment. Only three plants lived through the four weeks. No secondary roots were formed on these plants. A few mitotic divisions occurred in the roots from material fixed at 24 hours, and again in material fixed at 96 hours (fig. 2). Examination beyond this point was impossible due to the presence of bacteria in this group of plants.

Plants treated with 1000 ppm. MH were greatly inhibited in growth and never grew to a greater length than 3.7 centimeters. Two of the plants remained green during the four weeks. They did not increase in length during the four week period. The only mitotic figures observed in the plants of this group were in the material examined 24 hours after treatment.

The cells of the leaves of all plants, including the control, examined before the 72 hour interval contained large quantities of irregularly shaped inclusions. Seventy-two hours after treatment, no inclusions were found in the leaves of control, 10, or 50 ppm. plants. Inclusions were abundant even at the end of 168 hours in plants treated with 300, 500, and 1000 ppm. MH, but were not so abundant in plants treated with 100 ppm. MH. The inclusions gave negative reactions to tests for starch, fats and proteins.

Discussion. It is clear from the results of this experiment that growth and cell division are retarded in *Pisum sativum* when maleic hydrazide is used in concentrations of 100, 300, 500, and 1000 ppm. Although the amount of retardation increases with an increase in the concentration of MH, there is no direct proportion between the concentration of maleic hydrazide and the amount of growth inhibition in the plants.

In cytological examination of the roots previous to planting, the roots in treatments of 300, 500, 1000 ppm. MH exhibited differentiation of tissue almost to the root tip so that the region that is usually termed "meristematic" was almost absent in these plants. The nuclei of the cells in these tips were shrunken and the cells at the tip were extremely small. The characteristic swelling of these tips, as well as the extensive differentiation are properties usually attributed to growth substances (Levan 1939). Since no mitotic figures appeared in the 1000 ppm. plants after 24 hours, and only a few in the 300 and 500 ppm., growth in these plants must have been due to cell elongation. Evidently, either sufficient cell elongation and/or an in-

crease in cell division occurred in some of the plants to allow for a certain degree of recovery.

In the 100 ppm. group mitosis was retarded during the first 24 hours, but after this period the amount of retardation was slight, and at 96 hours was not detectable when based on the average number of divisions in comparison with the average number of divisions in the control plants at the same period. When the total number of divisions that occurred in the shoot and root tips of the control and the 100 ppm. treatment were computed, and the total lengths of the control and 100 ppm. treatment were compared, it seemed highly probable that the amount of growth inhibition occurring in the 100 ppm. was due to inhibition of cell division.

Greulach and Atchison (1950), using maleic hydrazide on the roots of *Allium cepa*, found solutions of 100 ppm. MH to be almost as effective in inhibition of cell division as solutions of 1000 ppm. but only a little more effective on growth in length than solutions of 1 ppm. MH. The results presented in this paper (that MH in concentrations of 100 ppm. is not nearly as effective as solutions of 1000 ppm. in inhibiting cell division) do not agree with those presented by Greulach and Atchison.

In contrast to higher concentrations of MH, the 50 and 10 ppm. treatments did not inhibit growth. If the average number of cell divisions per day are added, the control totals 2,478 divisions and the 10 ppm. group totals 2,370. The growth curve of these plants rose and fell but no more irregularly than would be expected since there was no constant growth pattern in the control (fig. 1).

Maleic hydrazide in concentrations of 10 ppm. seemed to have no effect on either cell division or cell elongation. Based on statistical methods, the increase in length of the 10 ppm. group over the controls was not significant.

Statistical analysis of the increased growth of the 50 ppm. group indicates that the increase is insignificant at the 144 hour period where the actual difference is 18.4 and the standard error of the difference is $\pm$ 9.2. There is also a significant difference at 168 hours where the actual difference is 21.6 and the standard error of the difference is $\pm$ 9.97.

This experiment indicates that the effect of maleic hydrazide on cell division is not coincident with its effects on total growth. Based on percentage mitosis in the treated plants as compared to the control, there was a greater percentage mitosis in the shoot tips than in the root tips of all the plants. In those plants in which mitosis reappeared after a period of complete inhibition, the greatest percentage of dividing cells occurred in the shoot tips. This seems to indicate that MH has a more pronounced effect on cell division in the roots than in the shoots.

Further evidence that this is the case was obtained when the plants that were allowed to grow in a flat for four weeks were dug up and examined.

In the plants that had survived the treatments, obvious growth had occurred in the shoot but the root had increased little or none in length.

Although these results substantiate a differential effect on mitosis in the shoots and roots of these plants, it is possible that the results might vary with the type of treatment used; i.e., soaking the entire plant, or merely spraying the tops.

In spite of the negative reactions to tests for starch, fats, and proteins, it seems highly probable that the inclusions in the leaves of plants treated with high concentrations of MH were some type of food, possibly a polysaccharide other than starch, since they were not utilized in the plants which exhibited severe growth inhibition. The persistence of such food inclusions could be due to either the failure to use the food in assimilation or to a reduced rate of respiration (Naylor and Davis 1951, Isenberg, Odland. Popp and Jensen 1951) or both concurrently. A further study of these inclusions is proposed.

SUMMARY

1. Seeds of *Pisum sativum* were treated with 10, 50, 100, 300, 500, and 1000 ppm. solutions of maleic hydrazide and observations were made to determine the effects of MH on cell division and on total growth.

2. Inhibition of growth was apparent in treatments of and above 100 ppm. MH, and inhibition of cell division was noted in the 50 ppm. group as well as in the higher concentrations.

3. Based on the percentage mitosis in the treated plants, there was a greater percentage of mitosis in the shoot tips than the root tips.

4. Certain effects of the higher concentrations of MH on cellular structure are discussed.

Department of Botany, University of North Carolina
Chapel Hill, North Carolina

Literature Cited

Currier, H. B. & Crafts, A. S. 1950. Maleic Hydrazide, a selective herbicide. Science **111**: 152–153.

Darlington, D. C. & McLeish, J. 1951. Action of maleic hydrazide on the cell. Nature **167**: 407–408.

Greulach, V. T., & Atchison, E. 1950. Inhibition of growth and cell division in onion roots by maleic hydrazide. Bull. Torrey Club **77**: 262–267.

Isenberg, F. M. R., Odland, M. L., Popp, H. W. & Jensen, C. O. 1951. The effect of Maleic Hyrazide on certain dehydrogenases in tissues of onion plants. Science **113**: 58–60.

Levan, Albert. 1939. Cytological phenomena connected with the root swelling caused by growth substances. Hereditas **25**: 87–96.

Naylor, A. W., & Davis, O. L. 1951. Respiration response of root tips to Maleic Hydrazide. Bull. Torrey Club **78**: 73–79.

Schoene, D. L., & Hoffman, O. L. 1949. Maleic Hydrazide, a unique growth regulant. Science **109**: 588–598.

BULLETIN OF THE TORREY BOTANICAL CLUB
VOL. 79, NO. 3, PP. 212–234 MAY, 1952

UREDINALES FROM VARIOUS REGIONS[1]

GEORGE B. CUMMINS

In this paper 47 species of plant rusts are considered. Of this number 38 are described as new species, two as new varieties, and seven are redescribed or reduced to synonymy. The specimens originated in the Americas, Africa, Cyprus, India, and New Guinea. Following the designation of the type the deposition of type material is indicated as follows: A. H. = Arthur Herbarium; C. M. I. = Herbarium of the Commonwealth Mycological Institute; N. Y. = New York Botanical Garden; S. Af. = Mycological Herbarium, Union Department of Agriculture, South Africa; Stock. = Naturhistoriska Riksmuseet, Stockholm; U.S.D.A. = Mycological Collections, United States Department of Agriculture.

Aecidium margarettae Cummins, sp. nov. Spermogoniis amphigenis, subepidermalibus, globoideis, 100–135 μ diam., paraphysatis. Aeciis hypophyllis, in maculis flavidis usque ad 1 cm. diam. dense aggregatis, breviter cupulatis, 200–250 μ diam., flavidis; peridio primitus occluso, demum revoluto inciso, cellulis peridii firme conjunctis, imbricatis, rhomboideis vel ellipsoideis, 15–23 × 25–30 μ, pariete exteriore minute punctato, 2.5–3 μ crasso, interiore rugoso-verrucoso, 3.5–4 μ crasso; aeciosporae globoideae vel late ellipsoideae, 14–18 × 16–20 μ; membrana hyalina, subtiliter verruculosa, 1 μ crassa.

On leaves and nodes of *Margaretta whytei* K. Schum., Cholo, Nyasaland, Dec. 12, 1949, *P. O. Wiehe 492* Type! (A. H., C. M. I.).

Aecidium tafoense Cummins, sp. nov. Spermagoniis perpaucis, verisimiliter abortivis, vel nullis, subepidermalibus, globosis, 100 μ diam. Aeciis hypophyllis, breviter cupulatis, margine erosis, 0.2–0.25 mm. diam., flavidis; cellulis peridii ovalibus vel oblongis, 15–19 × 20–26 μ, pariete interiore verrucoso 2–2.5 μ crasso, exteriore levi 3 μ crasso; aeciosporae globoideae vel plus minusve oblongae, 9–15 × 12–16 μ membrana 0.5 μ crassa, hyalina, minuteque verruculosa.

On leaves of *Tylophora conspicua* N. E. Br., Tafo, Gold Coast, June 10, 1946, *P. M.* and *H. Owen 436* Type! (A. H., C. M. I., S. Af.), July 16, 1947, *H. Owen 572*.

Aecidium wiehei Cummins, sp. nov. Spermogoniis non visis, verisimiliter nullis. Aeciis hypophyllis vel caulicolis in maculis flavobrunneis 0.5–1.0 mm. aggregatis vel subinde solitariis, breviter cupulatis, 0.2–0.4 mm. diam., peridio inciso plus minusve revoluto, cellulis peridii rhomboideis vel ellipsoideis, 14–18 × 29–35 μ, pariete exteriore punctato-striato 4–6 μ crasso,

[1] Cooperative investigations between the Purdue University Agricultural Experiment Station and the Division of Mycology and Disease Survey, Bureau of Plant Industry, Soils, and Agricultural Engineering, United States Department of Agriculture. Journal Paper Number 545, of the Purdue University Agricultural Experiment Station. Contribution from the Department of Botany and Plant Pathology.

interiore rugoso-verrucoso 2.5–3.5 μ crasso; aeciosporae globoideae, rarius ellipsoideae, 14–18 × 15–19 μ; membrana minute verruculosa, hyalina, 1 μ crassa.

On leaves and stems of *Salvia pseudococcinea* Jacq., Zomba, Nyasaland, Mar. 11, 1950, *P. O. Wiehe 587* Type! (A. H., C. M. I., S. Af., Stock., U.S.D.A.).

Only three rusts of *Salvia* have been reported for Africa, *Puccinia salviae* Unger, *P salviae-interruptae* Maire, and *P. salviae-runcinatae* Doidge. Aecia are reported only for the last named, which has spermogonia and larger aeciospores.

Angiopsora wiehei Cummins, sp. nov. (fig. 2). Spermogoniis et aeciis ignotis. Urediis hypophyllis, vel rarius epiphyllus, rotundatis, minutis, 100–175 μ diam., subepidermalibus, flavidis, paraphysibus peripheralibus copiosis, incurvatis, uniseptatis, hyalinis, 8–15 μ latis, 45–85 μ longis, membrana in parte dorsali et apicali 2–7 μ crassa, in parte ventrali 1.5 μ crassa; urediosporae late ellipsoideae, 16–20 × 23–27 μ; membrana hyalina vel pallide flavida, 1–1.5 μ crassa, minuteque echinulata, poris germ. obscuris. Teliis hypophyllis, dense aggregatis, atro-brunneis, soris individuis 0.2–0.6 mm. diam. vel confluentibus, indehiscentibus; ex cellulis 2 vel 3 (vel 5) catenulatim compositis; teliosporae oblongae vel cuboideae, 6–14 × 16–40 μ, sessiles; membrana aureo- vel castaneo-brunnea, 1.5 μ crassa, ad apicem cellulae supremae 4–6 μ incrassata.

On leaves of *Erlangea ? marginata* S. Moore, Zomba Mt., Nyasaland, August 14, 1950, *P. O. Wiehe 828* Type! (A. H., C. M. I., S. Af., Stock., U.S.D.A)

The variation in the size of the teliospores results from the fact that the uppermost spores are usually longer than those below. When there are more than two spores in a chain the third, fourth, etc., are usually short and nearly cubical. Commonly there are only two spores in each chain so that *A. wiehei* has greater similarity to species on grasses than do most other species on dicot hosts.

It is probable that this species also occurs in Uganda on *Erlangeae tomentosa* S. Moore. Wakefield and Hansford (Proc. Linn. Soc. Lond. **161**: 179. 1949) describe uredia (under *Puccinia erlangeae* Grove) in one collection (Hansford No. 1119) which may well be those of *A. wiehei* and doubtless do not belong to *P. erlangeae*.

Cerotelium combreti Cummins sp. nov. Spermogoniis et aeciis ignotis. Urediis hypophyllis, sparsis vel plus minusve dense aggregatis, subepidermalibus, rotundatis, minutis, 90–125 μ diam., poro centrali apertis, pulverulentis, cinnamomeo-brunneis; paraphysibus periphericis copiosis, deorsum coalitis incurvatis, 5–8 × 25–40 μ, membrana hyalina, parte dorsali 3–5 μ crassa, ventrali 1 μ crassa; urediosporae obovoideae vel ellipsoideae, 14–20 × 22–28 μ; membrana hyalina vel pallide flavida, minuteque echinulata, poris germ. obscuris, verisimiliter 4 vel 5, equatorialibus. Teliis perpaucis, subepidermalibus, hypophyllis, ex sporis 4–7 catenulatim compositis;

teliosporae cuboideae vel oblongae, 9–15 × 10–19 μ; membrana 1–1.5 μ crassa, hyalina. Statim germ.

On leaves of *Combretum* sp., Kisube, Entebbe, Uganda, Oct. 1944, *C. G. Hansford 3616* Type! (A. H., C. M. I., S. Af., Stock., U.S.D.A.).

Very few telia were found, which leaves some uncertainty as to the accuracy of the above description. Although no basidia were seen the apical spores apparently germinate and collapse.

Of the rusts previously described on *Combretum, Uredo longaensis* P. Henn. has catenulate urediospores, *U. combreti* Kern & Thurst. has larger strongly echinulate spores and no paraphyses, and *U. combreticola* Doidge has smaller verruculose spores and no paraphyses.

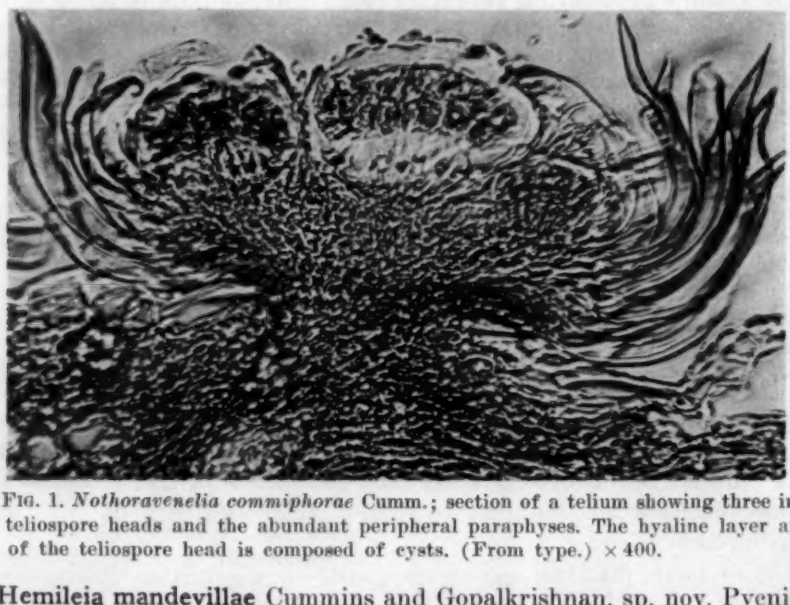


FIG. 1. *Nothoravenelia commiphorae* Cumm.; section of a telium showing three immature teliospore heads and the abundant peripheral paraphyses. The hyaline layer at the base of the teliospore head is composed of cysts. (From type.) × 400.

Hemileia mandevillae Cummins and Gopalkrishnan, sp. nov. Pycniis et aeciis ignotis. Urediis hypophyllis, minutissimis, partes majores foliorum dense obtegentibus vel in greges minutos aggregatis, flavidis, pulverulentis, per stomata erumpentibus; urediosporae plus minusve reniformae vel ellipsoideae, 16–20 × 21–26 μ; membrana hyalina, uniformiter 1.5–2 μ crassa, in parte superiore moderate echinulata, in parte inferiore plus minusve levibus; poris germ. obscuris. Teliis urediis conformibus; teliosporae leves, angulato-globosae vel irregulariter et varie lobatae, 18–26 μ latae, 13–18 μ altae; membrana hyalina, 1 μ crassa. Statim germantibus.

On leaves of *Mandevilla* sp., Nairobi, Kenya, Nov. 1939, *R. M. Nattrass 1055* Type! (A. H., C. M. I.).

In common with many species of *Hemileia* the guard cells of the host are not disrupted, the emergent sporogenous hyphae conforming to the size of the stomatal aperture. Only a limited substomatal mycelium is developed

in the form of slightly inflated cells. No obvious "feeder" hyphae, such as occur in *H. holarrhenae* Syd. and *H. strophanthi* Racib., are formed. Aside from lacking obvious feeder hyphae and having smaller teliospores *H. mandevillae* is nearer to *H. holarrhenae* than it is to other apocynaceous species.

Nothoravenelia commiphorae Cummins, sp. nov. (fig. 1). Spermogoniis et aeciis ignotis. Urediis hypophyllis, subepidermalibus dein erumpentibus, corbiculoideis, rotundatis, 200–500 μ diam., flavo-brunneis vel pallidioribus; paraphysibus peripheralibus copiosis, incurvatis, subinde immixtis, scimitriformibus, 10–15 × 100–170 μ, ad apicem acutis, flavo-brunneis vel fere hyalinis, membrana ubique 1 μ crassa vel ad apicem usque 6 μ incrassata; urediosporae ellipsoideae vel obovoideae, 16–19 × 23–30 (– 32) μ; membrana 2.5–3 μ crassa, dense echinulata, hyalina vel flavo-brunnea, poris germ. obscuris. Teliis urediis conformibus sed atro-brunneis; capitulis teliosporarum planoconvexis, obscure castaneo-brunneis, 90–175 μ diam., ex sporis 5–10 in omni directione compositis; sporis singulis bicellularis, puccinioideis, 15–23 μ diam., 35–45 μ altis, tuberculis hyalinis irregulariter obsitis; membrana castaneo-brunnea, 1.5–2.5 μ crassa, ad apicem 4–6 μ crassa; cystidiis tot quot sporis singulis, hyalinis, in aqua intumescentibus et ruptis; pedicello proprio nullo.

On leaves of *Commiphora pilosa*, Zomba, Nyasaland, Mar. 17, 1950, *P. O. Wiehe 608;* on *Commiphora* sp., Ncheu, Nyasaland, Mar. 26, 1950, *Wiehe 610* Type! (A. H., C. M. I., S. Af., Stock, U.S.D.A.).

This species differs from the previously known species, *N. japonica* Diet., on *Securinega,* in the very long sharp-pointed paraphyses, the smaller teliospore heads, and the fact that several spore heads are developed simultaneously in a single sorus. Moreover, in *N. commiphorae* the spore head is covered by a hyaline or yellowish layer with irregular, flat, tubercle-like elevations. Initially this layer is indistinguishable from the apical wall of the spore but with maturity the wall becomes pigmented while the outer layer remains pale. No outer layer is present in *N. japonica.* With these minor exceptions the two species seem to be similar in development.

The sori are characteristic. While they originate subepidermally they become erumpent, expanded, and basket-like with a broad thick base surmounted by a multiseriate fringe of paraphyses. Occasionally, paraphyses also occur within the sorus between the spore heads, especially in the large sori which produce several spore heads. In *N. japonica* successive crops of spore heads are reported to be formed by a single sporogenous layer. Some evidence was found to indicate that this may also occur in *N. commiphorae.*

Uromyces paradoxus Syd., which occurs on *Commiphora* sp. in Portuguese East Africa, doubtless is closely related. The structures reported as teliospores are undoubtedly paraphyses and differ from those of *N. commiphorae* only in being described as 50–70 μ long. The urediospores also appear to be similar but slightly larger.

Phragmidiella africana Cummins, sp. nov. Spermogoniis et aeciis ignotis. Urediis hypophyllis, minutis, 0.1–0.3 mm. diam., sparsis vel laxe aggregatis,

obscure cinnamomeo-brunneis, pulverulentis, paraphysibus immixtis perpaucis, aureo-brunneis, cylindraceis; urediosporae asymmetricae, globoideae vel oblato-sphaeroideae vel triangulatae, 19–23 μ latae, 18–25 μ ultae; membrana cinnamomeo-brunnea, 1.5 μ crassa, moderate echinulata, poris germ. 3, aequatorialibus. Teliis valde inconspicuis minutis, 75–125 μ diam., subepidermalibus, pallide flavidis, ex cellulis 2 vel 3 superpositis; teliosporae cuboideae vel oblongae, 12–14 × 15–22 μ, catenulatae, lateraliter non vel vix conjunctae; membrana hyalina vel pallide flavo-brunnea, 0.5–1 μ crassa. Statim germinantibus.

On leaves of *Stereospermum acuminatissimum* K. Schum., Panguma, Sierra Leone, Feb. 11, 1944, *F. C. Deighton 2345* Type! (A. H., C. M. I.); on *Stereospermum kunthianum* Cham., Kawanda, Uganda, July 1944, *C. G. Hansford 3515.*

The species is referred to *Phragmidiella* in the belief that the genus is valid and cannot be considered as synonymous with *Kuehneola* as treated by the Sydows (Monogr. Ured. **3**: 314, 318. 1915). While working in this laboratory K. S. Gopalkrishnan found in *P. markhamiae* P. Henn., the type of the genus, that the spermogonia and uredinoid aecia are subcuticular. Moreover, the teliospores are catenulate, acropetal as to development, and basipetal as to germination. They are not borne on pedicels. It is difficult to determine the number of spores in a chain since the upper spores germinate and collapse.

In *P. africana* no telia were seen with more than three spores in a chain but none were germinating nor had the telia ruptured the epidermis. The urediospores are nearly globoid when the pores are in the optical axis but triangular when the hilum is in the optical axis. One pore is located in each of the angles. The spores are borne in clusters on basal cells. The paraphyses mentioned in the description are cylindrical and usually one-septate. They may be uniformly thin-walled and hyaline or the upper half often appears to be solid and is then golden-brown. Paraphyses are irregular in occurrence and of doubtful diagnostic value.

A similar rust, *P. heterophragmae* (Mundk. & Thirum.) Thirum. & Mundk. occurs in India on *Heterophragma roxburghii.*

Prospodium oblectum Sydow, sp. nov. (fig. 4). Spermogoniis amphigenis, subcuticularibus, conicis. Aeciis uredinoideis, subcuticularibus, amphigenis, circum spermogonia confluentibus in maculis usque ad 8 mm. longis, cinnamomeo-brunneis, pulverulentis; aeciosporae plerumque obovoideae vel ellipsoideae, 24–30 × 29–38 μ; membrana 3.5–7 μ cr., flavida vel cinnamomea, indistincte laminata, aculeata, poris germ. 2, aequatorialibus. Urediis non visis, verisimiliter nullis. Teliis aeciis consociatis vel sparsis, subepidermalibus, pulvinatis, 125–150 μ diam., obscure cinnamomeo-brunneis; teliosporae ellipsoideae, utrinque rotundatae, medio constrictae, 23–26 × 33–38 (–40) μ; membrana uniformiter 1.5–2 μ cr., pallide castaneo- vel obscure cinnamomeo-brunnea, minuteque echinulata, poro superiore apicali, inferiore juxta pedicellum; pedicello hyalino yel pallide flavidulo, 6–10 μ lato, usque ad 70 μ longo, medio 1-septato, semipersistenti.

On leaves of *Clytostoma callistegioides* (Cham.) Bur., Piratiny pr. Pelotas, Prov. Rio Grande do Sul, Brazil, Nov. 3, 1901, *G. O. A. Malme 173* (type of *P. oblectum* Syd., aecial stage); Conception del Uruguay, 1878, *Lorentz* (type of *Uromyces hieronymianus* P. Henn., an aecial stage), Uruguay, 1933, *G. W. Herter;* La Plata, Argentina, Nov. 22, 1942, *J. C. Lindquist,* Aug. 14, 1944, *Lindquist* Type! (A. H., Museo de La Plata).

When Sydow (Ann. Mycol. **30**: 95. 1932) published the description of this species only the spermogonia and aecia were known. The name was antedated by *Uromyces hieronymianus* P. Henn. (Hedwigia **33**: 229. 1894), likewise based on uredinoid aecia. Although both authors placed the species in valid genera neither name was based on telia, or even on ordinary uredia, and consequently neither name is actually valid, as pointed out by Cummins (Lloydia **3**: 75. 1940). The discovery of telia by Lindquist in Argentina proves the species to be a *Prospodium.* In order to avoid further confusion the species is redescribed under Sydow's name, with Lindquist's collection cited as the type.

P. oblectum is generally similar to *P. constrictum* Cumm. and *P. anemopaegmatis* (P. Henn.) Cumm. but the aeciospores do not have obviously bilaminate walls nor a clearly defined apical cap. The wall merely becomes progressively paler outwardly. The aeciospores were illustrated by Cummins (*l. c.*).

PUCCINIA AMPHIOSPORA Cumm., Bull. Torrey Club **67**: 67. 1940 (*Uredo amphiospora* Jacks. & Holw., Mycologia **24**: 72. 1932). On leaves of *Hyptis mutabilis* (Rich.) Briq., Gainesville, Fla., Nov. 24, 1943, Windsor, Fla., Dec. 11, 1943, San Mateo, Fla., May 5, 1944, *A. S. Rhoads* (Specimens in the Mycol. Coll. U. S. Dept. Agric.).

On the basis of the above cited specimens, which bear various combinations of uredia, amphisori, and telia, it is obvious that *P. amphiospora* is nothing more than an amphisporic variant of *Puccinia hyptidis-mutabilis* Mayor. Since the latter name is older *P. amphiospora* should be reduced to synonymy.

PUCCINIA CENCHRI Diet. & Holw. var. **africana** Cummins, var. nov. (*Uredo cenchricola* P. Henn., Flora du Bas- et Moyen-Congo in Annal. Mus. Congo II, fasc. III: 223. 1908). A forma typica differt poris germ. urediosporae 4 vel 5 aequatorialibus.

On leaves of *Cenchrus ciliaris* Fig. & De Not., Kawanda, Uganda, Mar. 1941, *C. G. Hansford 2987,* July 1944, *Hansford 3517* Type! (A. H., C. M. I., S. Af., Stock, U.S.D.A.).

The few teliospores found in the type are so similar to those of *P. cenchri* that the greater number of pores in the urediospores does not seem to warrant specific rank. The urediospores measure 23–29 × 29–44 μ and the teliospores 16–21 (–25) × (35–) 40–49 μ. Occasional three-celled teliospores occur.

Hennings' original record was on *Cenchrus* sp. from Dolo, Congo.

Puccinia claytoniicola Cummins, sp. nov. (fig. 7). Spermogoniis, aeciis, et urediis ignotis. Teliis subepidermalibus, pulverulentis, cinnamomeo-brunneis, amphigenis, in gregibus usque ad 2 cm. longis dense dispositis, vel plus minus totam superficiem occupantibus, plantam nutricem frequenter leniter deformantibus; teliosporae ellipsoideae, rarius oblongo-ellipsoideae, medio lenissime constrictae, 14–18 × 22–31 μ; membrana uniformiter 1.5 μ cr., supra poros papilla minuta provisa, cinnamomeo-brunnea, verrucis in lineas 4–8 longitudinaliter dispositis praedita; poro superiore apicali, inferiore basali; pedicello hyalino, brevi, fragili, non-persistenti.

On leaves, stems, and inflorescence of *Claytonia laneolata* Pursh (*C. rosea* Rydb.), Headquarters Park, Medicine Bow Mts., Wyo., July 8, 1947, *W. G. Solheim 2155* Type! (A. H., U.S.D.A., Univ. Wyo.).

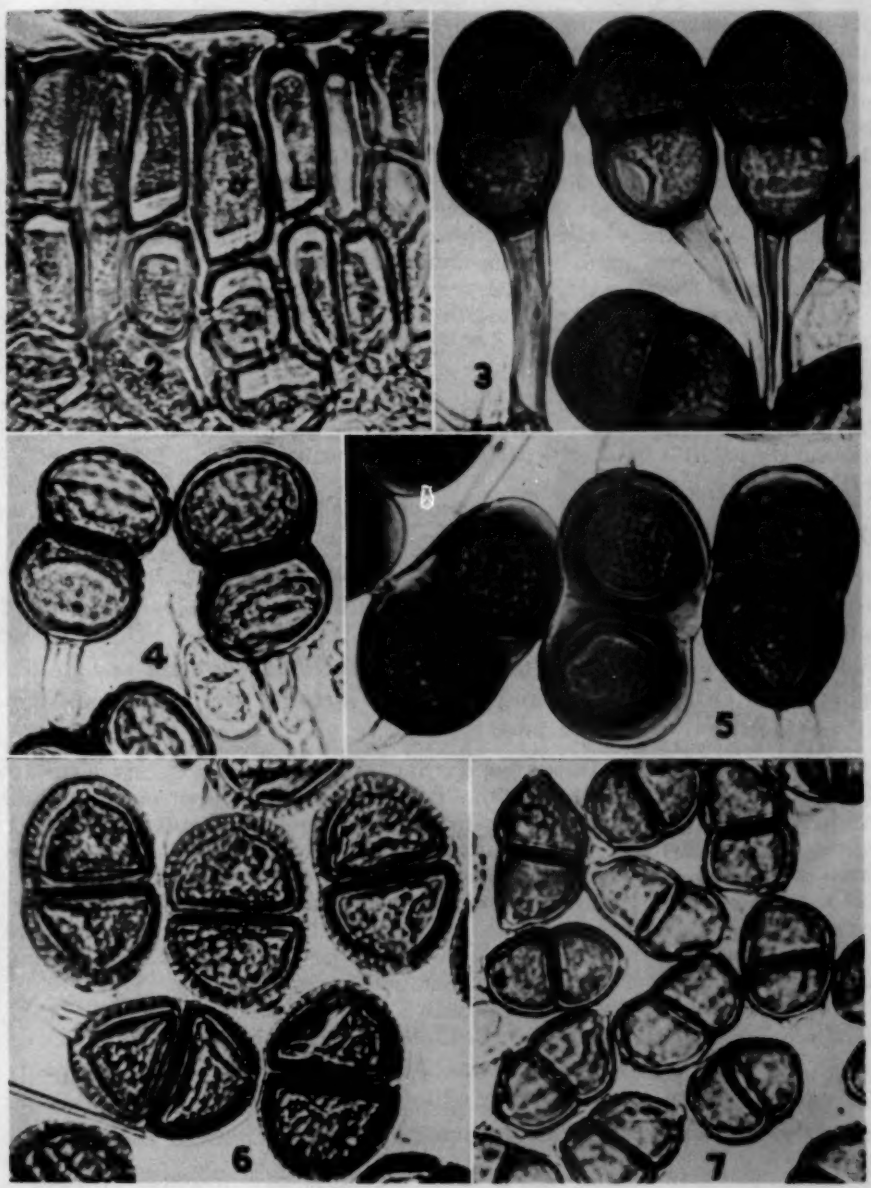
Puccinia claytoniicola is doubtless microcyclic. It differs sharply from the macrocyclic *P. mariae-wilsoni* G. W. Clint. because of much smaller teliospores thinly warted in longitudinal lines. Although the telia occur more or less uniformly over a plant or plant part the rust is probably not perennial but possibly locally systemic.

PUCCINIA CUCUMERIS P. Henn. On leaves of *Cucumis africana* Lindl., Zomba, Nyasaland, Mar. 17, 1950, *P. O. Wiehe 603.*

The Sydows (Monogr. Ured. **1**: 200. 1904) describe only aecia and telia, commenting that the aecia resemble uredia. Viégas (Bragantia **5**: 22. 1945) describes uredia and telia but no aecia, concluding that the Sydows' description of aecia probably referred to the uredia. Wiehe's specimen lacks spermogonia but has abundant aecia along with a few uredia and telia. Actually, all sori are much alike in form being round, dome-shaped because of the uplifted epidermis which ruptures apically by a pore, and lacking a peridium or paraphyses. The aeciospores, which are catenulate, are pale yellowish and so finely verruculose as to appear almost smooth. The urediospores are pedicellate, pale cinnamon-brown, moderately to finely echinulate, and have two large equatorial pores. Macroscopically, the aecia and uredia can be distinguished only because the spores give the uredia a brownish color.

Both Viégas and the Sydows describe the teliospores as smooth. In Wiehe's collection, however, the spores vary from obviously rugose when immature to obscurely rugose when mature and fully pigmented. In fact, occasional spores appear smooth. When immature the wall is obviously bilaminate but at maturity seems uniform. While difficult to observe, the germ pore is adjacent to the septum in both cells.

Puccinia cyathulicola Cummins, sp. nov. (fig. 9). Spermogoniis epiphyllis, subepidermalibus, plus minusve globosis vel ellipsoideis, magnis, 150–200 μ latis, 200–250 μ altis. Aeciis hypophyllis, rarius epiphyllis, circum spermogonia dispositis, subepidermalibus, uredinoideis, in greges usque ad 3 mm. diam. plus minusve confluentibus, pulverulentis, cinnamomeo-brunneis; aeciosporae late ellipsoideae, ellipsoideae, vel obovoideae, 24–32 ×



FIGS. 2–7. FIG. 2. Vertical section of a telium of *Angiopsora wiehei* Cumm. (From type.) FIG. 3. Teliospores of *Puccinia isachnes* Petch. (From Koelz 19747.) FIG. 4. Teliospores of *Prospodium oblectum* Syd.; the pedicels in this species are unadorned. (From type.) FIG. 5. Teliospores of *Puccinia tripsacicola* Cumm. (From type.) FIG. 6. Teliospores of *Puccinia dombeyae* Cumm., a microcyclic species. (From type.) FIG. 7. Teliospores of *Puccinia claytoniicola* Cumm. (From type.) × 800.

30–46 μ; membrana uniformiter 2.5–3 μ cr., cinnamomeo-brunnea, minuteque echinulata, poris germ. 2, aequatorialibus. Urediis aeciis conformibus sed sparsis; urediosporae aeciosporis conformibus. Teliis aeciis et urediis conformibus et consociatis sed pulvinatis, compactis, cinnamomeis; teliosporae oblongae, oblongo-ellipsoideae, vel oblongo-clavatae, ad apicem rotundatae vel plus minus truncatae, ad basim attenuatae vel truncatae, medio vix vel moderate constrictae, 19–25 × 42–65 μ; membrana aureo-brunnea vel pallide castaneo-brunnea, ad apicem plus minus obscuriore, levi, 1–1.5 μ cr., ad apicem 7–12 μ incrassata, poris germ. in cellulis superioribus apicalibus, inferioribus juxta septum dispositis; pedicello hyalino, 8–15 μ lato, 30–50 μ longo, persistenti. Statim germinantibus.

On leaves of *Cyathula uncinulata* (Schrad.) Schinz, Dezda Mt., Nyasaland, Oct. 6, 1949, *P. O. Wiehe 426* Type! (A. H., C. M. I., S. Afr., Stock., U.S.D.A.).

PUCCINIA CYATHULICOLA Cumm. var. **kenyensis** var. nov. Cummins. *A* forma typica differt praecipue membrana aeciosporae et urediosporae ad apicem usque 10 μ incrassata; teliosporae lenissime minores, 20–26 × (40–) 45–52 (–58) μ.

On leaves of *Cyathula uncinulata* (Schrad.) Schinz, Kabete, Kenya, Dec. 1938, *R. M. Nattrass 1018* Type! (A. H., C. M. I.).

These two rusts differ from others on the Amaranthaceae because of the uredinoid aecia, large aeciospores and urediospores, and apically thickened teliospores which germinate without a period of dormancy. While the variety differs constantly from the species in having aeciospores and urediospores with an apical thickening and more strongly echinulate wall, they are obviously very closely related.

Puccinia dombeyae Cummins, sp. nov. (fig. 6). Spermogoniis, aeciis, et urediis ignotis, verisimiliter nullis. Teliis hypophyllis in maculis pallidis circinate vel dense aggregatis, obscure cinnamomeis, plus minusve pulverulentis, soris individuis rotundatis, 0.2–0.6 mm. diam.; teliosporae regulariter ellipsoideae, utrinque rotundatae, medio vix constrictae, 21–27 × 31–39 μ; membrana obscure cinnamomeo-brunnea, uniformiter 2–3 μ cr., minuteque reticulata vel rugoso-reticulata, poris germ. in cellulis superioribus apicalibus, inferioribus juxta pedicellum dispositis; pedicello hyalino, usque ad 50 μ longo sed fragili, plerumque deciduo.

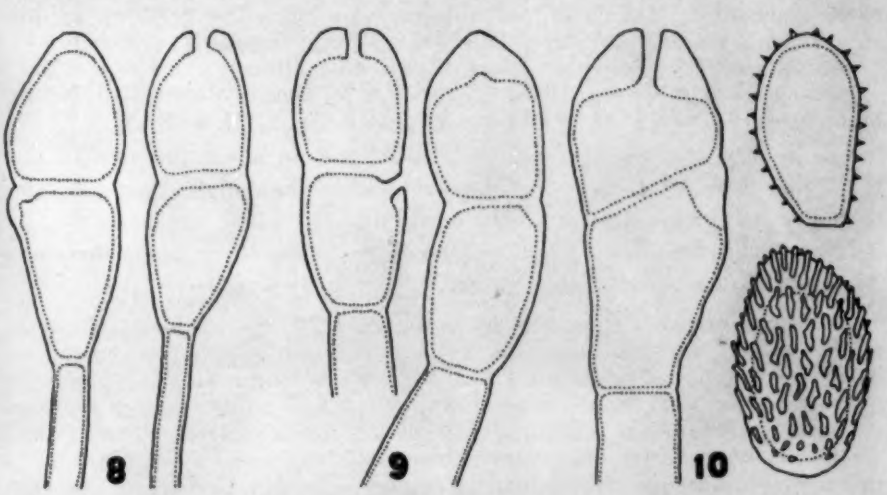
On leaves of *Dombeya nairobiensis* Engl., Limuru, Kenya, June 1950, *R. M. Nattrass 1413* Type! (A. H., C. M. I., S. Af., Stock., U.S.D.A.).

P. dombeyae differs from the few species of *Puccinia* recorded on the Sterculeaceae because of the uniformly thick and reticulate walls of the teliospores. It is probably closely related to *P. abutili* Berk. & Br.

Puccinia enixa Cummins, sp. nov. (fig. 10). Spermogoniis epiphyllis, paucis, subepidermalibus, plus minusve globosis, 170–200 μ diam., periphysibus breviter fasciculatis. Aeciis hypophyllis vel amphigenis, subepidermalibus, flavidis, caeomoideis, 0.2–0.4 mm. diam.; aeciosporae oblongo-ellipsoideae, ellipsoideae, vel late ellipsoideae, 22–32 × 35–48 μ; membrana hyalina, 3–4 μ cr., ad apicem 8–16 μ cr. et prominenter tuberculata, verrucis magnis irregularibus vel striaeformibus, vel apicem versus columniformibus

praedita. Urediis hypophyllis, sparsis, flavidis, pulverulentis, rotundatis, 0.1–0.3 mm. diam.; urediosporae variabiles, ellipsoideae, oblongae, vel piriformes, (16–) 18–24 × (26–) 33–42 (–46) μ; membrana hyalina, 1.5–2 μ cr., ad apicem plerumque 3 μ cr., moderate echinulata, poris germ. obscuris. Teliis urediis conformibus sed compactis; teliosporae plerumque oblongae vel clavato-oblongae, utrinque rotundatae vel deorsum attenuatae, medio moderate constrictae, 27–33 (–38) × (43–) 50–68 μ; membrana hyalina, levi, 1 μ cr., ad apicem 8–12 μ cr.; poris germ. in cellulis superioribus apicalibus, inferioribus juxta septum dispositis; pedicello hyalino, persistenti, 10–15 × 40–82 μ. Statim germinantibus.

On leaves of *Baccharis* sp., Turrialba, Costa Rica, Nov. 27, 1949, *A. S. Müller 1974* Type! (A. H., U.S.D.A.).



FIGS. 8–10. FIG. 8. Two teliospores of *Puccinia padwickii* Cumm. (From type.) FIG. 9. Two teliospores of *Puccinia cyathulicola* Cumm. This rust has uredinoid aecia. (From type.) FIG. 10. One teliospore, one urediospore, and one aeciospore of *Puccinia enixa* Cumm. All spore forms are pale in color. (From type.) × 800.

Among the many rusts of *Baccharis* this species is distinct because of the large teliospores which are greatly thickened apically and next the septum, and the large, apically thickened and very coarsely sculptured aeciospores. There is no pigment in the walls of any of the spores, thus all sori are yellowish. In general *P. enixa* is perhaps closest to *P. baccharidis-spartea* Jacks. & Holw. but differs in the characters mentioned above.

Puccinia guizotiae Cummins, sp. nov. (fig. 15). Spermogoniis aeciis, et urediis nullis. Teliis hypophyllis, subepidermalibus, pulvinatis, 0.1–0.3 mm. diam., cinnamomeo-brunneis, in maculis brunneis usque ad 6 mm. diam. dense aggregatis; teliosporae oblongo-ellipsoideae, ad apicem rotundatae, ad basim plerumque attenuatae, medio leniter constrictae, 16–19 × (35–) 40–55 μ; membrana flavo- vel aureo-brunnea, 1.5–2 μ cr., ad apicem 5–8 μ, levi; pedicello sporae aequante, persistenti, flavidulo. Statim germinantibus.

On leaves of *Guizotia scabra* Chiov., Semuto Road, Uganda, Dec. 1943, *C. G. Hansford 3320* Type! (A. H., C. M. I., U.S.D.A.).

This microcyclic rust is the first species of *Puccinia* reported on the genus *Guizotia*, a member of the Compositae.

Puccinia ibozae Cummins, sp. nov. (fig. 11). Spermogoniis at aeciis ignotis. Urediis subepidermalibus, hypophyllis, sparsis, rotundatis, 0.2–0.4 mm. diam., pulverulentis, cinnamomeo-brunneis; urediosporae oblato-sphaeroideae vel fere globosae, 22–29 μ latae, 21–25 μ altae; membrana cinnamomeo-brunnea, 1–1.5 μ cr., dense minuteque echinulata, poris germ. 4, equatorialibus. Teliis urediis conformibus sed atro-brunneis, pulvinatis; teliosporae ellipsoideae, utrinque rotundatae vel basim versus leniter attenuatae, medio vix constrictae, 25–30 (–32) × 42–56 μ; membrana lucide castaneo-brunnea, 2–2.5 μ cr., ad apicem 5–7 μ cr., poris germ. in cellulis superioribus apicalibus, inferioribus juxta septum dispositis; pedicello hyalino, usque ad 130 μ longo vel plerumque semi-cauduco.

On leaves of *Iboza multiflora* (Benth.) A. E. Bruce, Mwera Hill, Nyasaland, Aug. 19, 1949, *P. O. Wiehe 396* Type! (A. H., C. M. I., S. Af.).

As usually seen the urediospores appear globoid but if oriented so that the hilum is in view they are slightly broader than high. There is some tendency for the apical wall to be slightly darker.

No rust has been reported on species of the genus *Iboza* nor is there any African mint rust similar to *P. ibozae*.

Puccinia kenyana Cummins, sp. nov. (fig. 14). Spermogoniis, aeciis, et urediis ignotis, verisimiliter nullis. Teliis hypophyllis, nervicolis vel caulicolis, rarius epiphyllis, usque ad 4 mm. latis, 2 cm. longis, castaneo-brunneis, pulverulo-pulvinatis, epidermide disrupta cinctis; teliosporae ellipsoideae vel oblongo-ellipsoideae, utrinque rotundatae, medio vix constrictae, (23–) 25–30 × 35–48 μ; membrana castaneo-brunnea, 3–3.5 μ cr., supra poros 4–6 μ incrassata, minuteque verruculosa vel rugoso-reticulata, poris germ. in cellulis superioribus apicalibus, inferioribus juxta hilum dispositis; pedicello hyalino, fragili, deciduo.

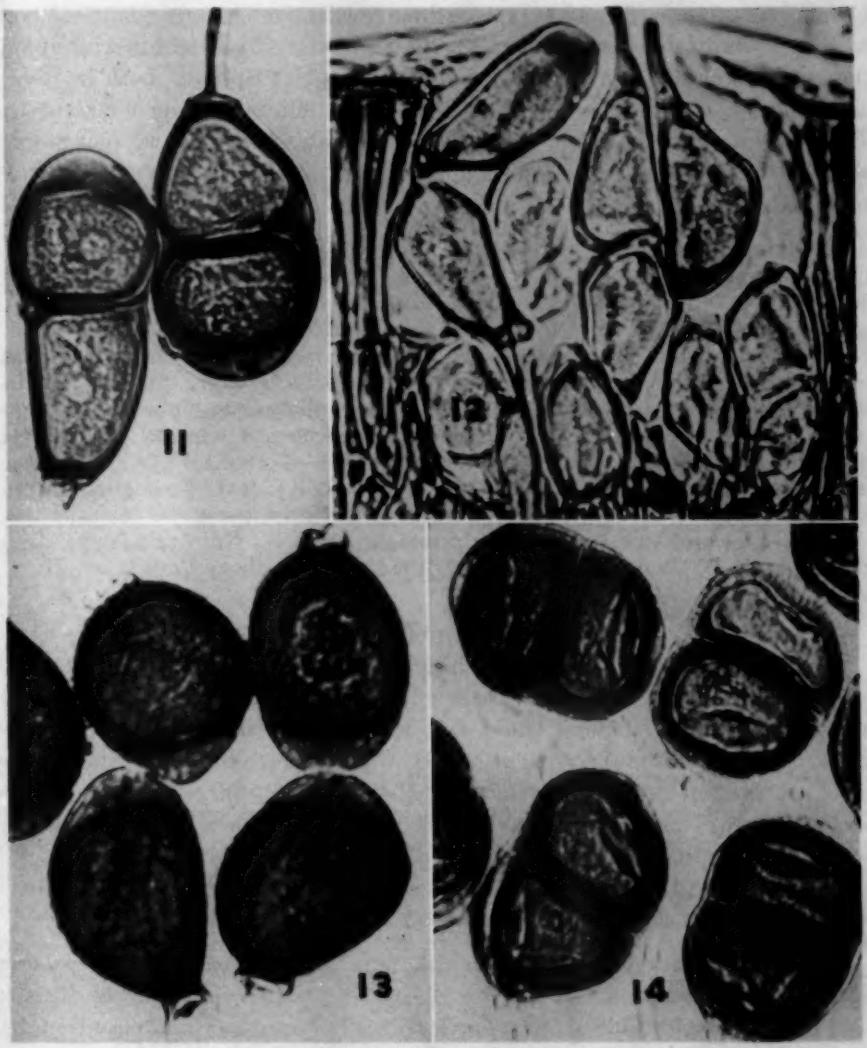
On leaves of *Vernonia cistifolia* O. Hoffm., Nairobi, Kenya, July 1940, *R. M. Nattrass 1075* Type! (A. H., C. M. I., S. Af., U.S.D.A.).

P. kenyana is nearest to *P. rotundata* Diet. in South America, as regards teliospores, although the spores of *P. rotundata* are somewhat smaller and the germ pore is midway in each cell. The telia are much smaller in *P. rotundata*.

PUCCINIA ISACHNES Petch (fig. 3). On *Isachne kunthiana* Wight & Arn., Ootacamund, Madras, India, *Walter Koelz 19747*.

This species has been reported previously only from Hakgala, Ceylon where it also occurs on *I. gardneri*. The type has been available for comparison through the courtesy of the Director of the Royal Botanic Gardens, Kew.

PUCCINIA LUPINICOLA Gäum. On old stems of *Lupinus benthami* Heller, Box Canyon, Joshua Natl. Monument, Calif., Mar. 5, 1947, *F. Went & E. Gäumann* Type!



FIGS. 11–14. FIG. 11. Teliospores of *Puccinia ibozae* Cumm. (From type.) FIG. 12. Vertical section of a telium of *Uromyces rhinacanthi* Cumm. Note the laterally compacted paraphyses which bound the spore-bearing locules. (From type.) FIG. 13. Teliospores of *Uromyces wolfii* Cumm. The spores are papillate-verrucose. (From type.) FIG. 14. Teliospores of *Puccinia kenyana Cumm.* (From type.) × 800.

It is doubtful if this is a valid species or that the host is actually *Lupinus*. The stems bearing telia are of the last season's growth so that an accurate identification is probably not possible. Gäumann (Ber. Schw. Bot. Ges. **57**: 247. 1947) does not state the authority for the identification. There occurs in the same region an autoecious, macrocyclic rust, *Puccinia thelypodii*

Cumm. (Mycologia **31**: 170. 1939) which is morphologically identical both as to telia and teliospores. *P. thelypodii* parasitizes *Thelypodium lasiophyllum* and is known from Claremont and Soboba Hot Springs, both in Riverside County. Comparison of the overwintered telium-bearing stems of the *Thelypodium* and the supposed *Lupinus* indicates that the two plants may well be the same. It is my opinion that *P. lupinicola* is a synonym of *P. thelypodii*.

Puccinia padwickii Cummins, sp. nov. (fig. 8). Spermogoniis et aeciis ignotis. Urediis hypophyllis, 0.2–0.5 mm. diam., sparsis vel aggregatis, vel caulicolis in incrassationibus ortis, cinnamomeo-brunneis, pulverulentis; urediosporae globoideae, ellipsoideae, vel late ellipsoideae, 21–26 × (24–) 28–38 μ; membrana cinnamomeo-brunnea, 2–2.5 μ cr., moderate echinulata, poris germ. 2, aequatorialibus. Teliis hypophyllis, sparsis, pulvinatis, cinnamomeo-brunneis, usque ad 0.5 mm. diam.; teliosporae clavatae, oblongo-clavatae, vel plus minusve oblongo- ellipsoideae, ad apicem rotundatae, deorsum attenuatae, medio vix constrictae, (16–) 18–21 (–23) × 40–60 μ; membrana aureo-brunnea, 1.5 μ cr., ad apicem 3–5 μ, levi; pedicello hyalino, 8–15 μ lato, 20–35 (–50) μ longo, persistenti. Statim germ.

On leaves and stems of *Cyathula tomentosa* Moq., Nainital, India, June 22, 1944, *G. W. Padwick 817*, Oct. 9, 1944, *Padwick 888* Type! (A. H., C. M. I.).

Uredo gomphrenae Barcl. is the uredial stage of this species.

Padwick No. 817 has galls, reaching a length of 2 cm. and a width and height of 8 mm., on the stems. These galls have the appearance of primary infections but spermogonia could not be found, perhaps due to displacement by the abundant sporulation. If these infections are primary the aecia are uredinoid. Spores from the galls are usually larger (up to 46 μ in length), darker brown, and have thicker walls (up to 5 μ at the sides or often thicker apically) than do the urediospores produced on the leaves.

The species is generally similar to *P. cyathulicola* Cumm. but has narrower teliospores with a less pronounced thickening of the apical wall.

Puccinia sphaeralceoides Cummins, nom. nov. (*Puccinia sphaeralceae* Gäum., Ber. Schw. Bot. Ges. **57**: 248–249. 1947, not *P. sphaeralceae* Ellis & Ev., Amer. Nat. **31**: 428. 1897). On leaves of *Phymosia rivularis* (Dougl.) Rydb., Grangerville, Ida., June 28, 1945, *G. W. Fischer;* on *Sphaeralcea ambigua* Gray, Cottonwood Springs, Joshua Natl. Monument, Calif., Mar. 3, 1947, *J. Westergaard & E. Gäumann* Type!; on *S. orcuttii* Rose, Seventy Nine Palms, San Bernardino Co., Calif., Feb. 22, 1947, *H. E. Parks 7072.*

This rust belongs in the life cycle complex with *Uromyces pencanus* Arth. & Holw., *Puccinia digna* Arth. & Holw., *P. interveniens* Bethel, *P. graminella* Diet. & Holw., *P. sherardiana* Koern., and *Endophyllum tuberculatum* (Ellis & Kellerm.) Arth. & Fromme. It is an *opsis* form but the spermogonia have been seen only on *Sphaeralcea orcuttii*. The aecia and telia

may be separate or intermingled, or telia may develop within aecia. The life cycles of these interrelated species are tabulated below:

Rust	Mallows	*Stipa*
Parent species (unknown)	O. I.	II. III.
Puccinia digna		I. II. III.
Uromyces pencanus		I. II. III.
Puccinia interveniens	O. I.	III.
Puccinia graminella		I. III.
Puccinia sphaeralceoides	O. I. III.	
Puccinia sherardiana	III.	
Endophyllum tuberculatum	III (aecidioid).	

Puccinia tripsacicola Cummins, sp. nov. (fig. 5). Spermogoniis et aeciis ignotis. Urediis incertis. Teliis hypophyllis, subepidermalibus, pulvinatis, oblongis, usque ad 3 mm. longis, aggregatis, atro-brunneis; teliosporae subinde diorchidioideae, plerumque ellipsoideae, utrinque rotundatae, medio plus minusve constrictae, (19–) 21–28 × (34–) 39–50 μ; membrana obscure castaneo-brunnea, 3–4 μ cr., ad apicem 5–7 (–9) μ, levi, poro superiore apicali, inferiore juxta septum sito; pedicello hyalino, persistenti, usque ad 100 μ longo.

On leaves of *Tripsacum dactyloides* L., Chimborazo, Ecuador, July 17, 1923, *A. S. Hitchcock* Type! (U.S.D.A.).

This species is clearly distinct from other rusts of *Tripsacum*. The most similar species is *P. tripsaci* Diet. & Holw. but it has considerably less robust spores with thinner walls.

In 1943 Kern and Thurston (Mycologia **35**: 445.) described *Uromyces tripsaci* on the same host from Venezuela. This rust has oblong teliospores with a single germ pore located adjacent to the hilum. The spores are very easily detached and retain no fragment of the pedicel. In the Hitchcock specimen the telia of *P. tripsacicola* occur directly opposite sori of *U. tripsaci*. The association is so intimate as to suggest that both spore forms belong to a single species. This close association, together with the peculiar one-pored spores described by Kern and Thurston leads to the tentative suggestion that the "teliospores" of *U. tripsaci* may actually be highly modified amphispores belonging in the life cycle of *P. tripsacicola*. Ultimate proof of this suggestion might require germination studies but it would be strengthened should additional specimens be found in which the two spore forms are closely associated.

P. tripsacicola appears to be an uncommon rust. Examination of the collections of *Tripsacum* in the U. S. National Herbarium failed to yield a single collection although numerous specimens were found infected with *P. tripsaci*.

PUCCINIA WENTII Gäum. On leaves of *Haplopappus acradenius* (Greene)

Blake var. *eremophila* (Greene) Munz, edge of Andreas Canyon, Indian Reservation, east of Palm Springs, Calif., Mar. 4, 1947, *E. Gäumann* Type!

This recently published (Ber. Schw. Bot. Ges. **57**: 246–247. 1947) species is to be considered as a synonym of *P. grindeliae* Peck, a much-named microcyclic rust widely distributed in the western states.

Puccinia wiehii Cummins, sp. nov. (fig. 16). Spermogoniis et aeciis ignotis. Urediis amphigenis, subepidermalibus, ellipticis, usque ad 1.0 mm. longis, seriatim dispositis, plus minusve confluentibus, flavidis, epidermide conspicue rupta; urediosporae plerumque obovoideae, 19–23 × 22–32 μ membrana 1.5–2 μ cr., ad apicem 5–10 μ, minuteque echinulata, hyalina vel pallide flavidula, poris germ. 3 vel 4, aequatorialibus, perobscuris. Teliis amphigenis, elongatis, usque ad 5.0 mm. longis, sparsis vel seriatim dispositis, pulvinatis, compactis, atro-brunneis; teliosporae ellipsoideae, oblongo-ellipsoideae, vel rarius clavatae, utrinque rotundatae, deorsum rotundatae vel leniter attenuatae, medio non vel vix constrictae, 20–26 × 34–50 μ; membrana 2–3.5 μ cr., ad apicem 8–12 μ cr., castaneo-brunnea, levi, poris germ. in cellulis superioribus apicalibus, inferioribus juxta septum dispositis; pedicello persistenti, hyalino, crasse tunicato, 5–7 μ lato, usque ad 120 μ longo, deorsum attenuato.

On leaves of *Setaria splendida* Stapf, Vipya, Nyasaland, Aug. 11, 1949, *P. O. Wiehe 369* Type! (A. H., C. M. I., S. Af., Stock., U.S.D.A.).

P. wiehe is generally similar to *P. eucomi* Doidge, a rust of the Andropogoneae in South Africa, but no *Setaria* rust is at all similar.

PUCCINIA sp. Spermogonia and aecia unknown. Uredia hypophyllous, *i. e.* abaxial, scattered, elliptical, up to 2 mm. in length, opening by a slit in the epidermis, cinnamon-brown; urediospores ellipsoid or oblong-ellipsoid, 19–23 × 27–36 μ; wall 2.5–3 μ thick, pale golden becoming cinnamon-brown, rather closely and finely echinulate, pores 6–8, scattered. Telia (one seen) epiphyllous, *i. e.* adaxial, round, 0.3 mm. diam., pulvinate, chestnut-brown; teliospores mostly clavate, rounded at the apex and narrowed basally, not or only slightly constricted at the septum, 13–18 × 46–63 μ; wall smooth, golden-brown, 1.5–2 μ thick, the apex thickened to 8 μ; pedicel persistent, rather thick-walled, as long as the spore or somewhat longer, golden. The spores germinate at once.

On leaves of *Luzuriaga marginata* (Jun.) Benth. & Hook., Puerto Arturo, Tierra del Fuego, Feb. 1, 1946, *J. G. Gibbs 53*.

While the species undoubtedly is undescribed it has not been formally named because the available material is scanty. It differs from *P. perforans* Mont. in having pulvinate rather than paraphysate, loculate telia. *P. perforans* appears to be microcyclic, moreover.

Ravenelia albizziicola Cummins, sp. nov. Spermogoniis et aeciis ignotis. Urediis amphigenis, subcuticularibus, flavo-brunneis, plus minusve rotundatis, 0.3–0.8 mm. diam., sparsis vel laxe aggregatis, cuticula rupta cinctis; urediosporae ellipsoideae vel subglobosae, 12–15 × 15–19 μ; membrana flavida vel aurea, minute echinulata, 1–1.5 μ cr., poris germ. 6–8 sparsis. Teliis urediis conformibus sed atro-brunneis; capitulis teliosporarum plano-convexis, obscure castaneo-brunneis, 70–95 μ diam., ex sporis 6–9 in omni direc-

tione compositis, sporis marginalibus papilla singula 4–5 × 5–10 μ obsitis; sporis singulis unicellularibus, 12–15 μ latis, 25–33 μ altis; membrana 1–1.5 μ cr. pallide flavida, ad apicem 5–7 μ, obscure castaneo-brunnea; cystidiis tot quot sporis, globosis, pendulis, hyalinis, in aqua facile diffluentibus; pedicello brevissimo, cauduco.

On leaves of *Albizzia harveyi* Fourn., Dedza, Nyasaland, Mar. 27, 1950, *P. O. Wiehi 611* Type! (A. H., C. M. I., S. Af.).

I have record of ten species of *Ravenelia* described as parasitizing species of *Albizzia*. *R. albizziicola* differs from all of them because of the subcuticular position of the sori, the small urediospores having scattered pores, and the restriction of the papillae to the marginal teliospores.

Ravenelia wiehei Cummins, sp. nov. Spermogoniis et aeciis ignotis. Urediis epiphyllis, subepidermalibus, cinnamomeo-brunneis, pulverulentis, epidermide disrupta cinctis, rotundatis, 0.4–1.0 mm. diam., in greges minutos dense aggregatis, eparaphysatis; urediosporae obovoideae, ellipsoideae, vel oblongo-ellipsoideae, (19–) 22–27 (–30) × (31–) 33–42 (–50) μ; membrana 1.5–2 μ cr., ad apicem 4–8 μ cr., valde echinulata, obscure cinnamomeo-brunnea vel castaneo-brunnea, poris germ. 2, raro 3 vel 4, aequatorialibus. Teliis epiphyllis, subepidermalibus, atro-brunneis, plus minus pulverulentis, circum uredia dense aggregatis et circinater dispositis, greges usque ad 7 mm. diam., vel sparsis; capitulis teliosporarum convexis, 35–55 μ diam., ex cellulis 4–7 compositis, obscure castaneo-brunneis vel olivaceo-brunneis, levibus; sporis singulis 18–26 μ diam., unicellularibus; membrana 2 μ cr., ad apicem 3–3.5 μ cr.; cystidiis pendulis, globosis, tot quot sporis, in aqua facile diffluentibus; pedicello brevissimo, cauduco, hyalino, ex hyphis paucis composito.

On leaves of *Cassia* sp., near *C. singueana* Del., Neno, Nyasaland, July 2, 1949, *P. O. Wiehe 323* Type! (A. H., C. M. I., S. Af., U.S.D.A.).

I have record of 20 species of *Ravenelia* occurring on species of *Cassia* and *R. wiehei* is entirely distinct, primarily because of the large, apically thickened urediospores. The teliospore heads have fewer spores than the other species with usually four marginal and one, two, or three central spores. In addition to the pigmented wall of the teliospores there is also an outer yellowish layer 2.5–3 μ thick. The pedicel is early deciduous and can be seen only in sections of immature telia.

Uraecium africanum Cummins, sp. nov. (fig. 18). Spermogoniis amphigenis, subcuticularibus, hemisphaericis vel conicis, minutis, 40–55 μ altis, 70–100 μ latis, eparaphysatis, maculas inerassatulas, atro-brunneas, usque ad 4 mm. diam. occupantibus. Aeciis pyeniis consociatis, subepidermalibus, plus minusve profunde immersis, rotundatis, 165–300 μ diam., brunneis, uredinoideis, paraphysibus peripheralibus, bi- vel multi-furcatis copiosis, 1–3 septatis, cylindraceis, ad apicem rotundatis vel acutis, hyalinis vel rufo-brunneis, 8–20 μ latis, usque 100 μ longis, membrana in cellulis basalibus 1–1.5 μ cr., in cellulis apicalibus usque ad 50 μ cr.; aeciosporae obovoideae, piriformibus, vel ellipsoideis, (20–) 23–28 × 29–34 (–37) μ; membrana flavida vel pallide brunnea, 1–1.5 μ cr. valde echinulata, poris germ. obscuris, verisimiliter 3, plus minus aequatorialibus.

On leaves of *Baphia nitida* Lodd., Beposo, Gold Coast, May 9, 1949, *S. J. Hughes 471* Type! (A. H., C. M. I.).

This rust has the superficial appearance of *Chaconia baphiae* (Cumm.) Thirum. & Cumm. on the same host and may prove to be the aecial stage of a species of *Chaconia*. *C. baphiae* is microcyclic and lacks paraphyses so the two are not identical.

The pharaphyses are the characteristic feature of *U. africanum*. Two or more arise as branches from a common basal cell. Each paraphysis is usually septate with the lumen of the terminal cell very narrow or lacking. As a consequence the terminal cell is almost solid except near the septum. They range in color from hyaline to reddish brown and are often sharply pointed. The germ pores of the aeciospores seem to be large but are, nevertheless, difficult to observe but probably are three near the equator or variably placed in the upper one-half of the spore.

Uraecium carpodini Cummins, sp. nov. (fig. 20). Spermogoniis amphigenis, paraphysatis, subepidermalibus, conicis, 110–130 μ latis, 65–100 μ altis, Aeciis amphigenis, uredinoideis, 0.1–0.4 mm. diam., circum spermogonia circinatim confluentibus; aeciosporae variabiles sed plerumque obovoideae, 24–30 (–34) × 33–40 (–45) μ membrana bilaminata, usque ad 7 μ cr., membrana exteriore hyalina 3–5 μ cr., interiore aureo-brunnea 1.5–2 μ cr., moderate echinulata; poris germ, non visis; pedicello hyalino, 8–10 μ longo, non-persistenti.

On leaves of *Carpodinus dulcis* Sabine, Port Loko, Sierra Leone, May 29, 1948, *F. C. Deighton 2654* Type! (A. H., C. M. I., S. Af., U.S.D.A.).

The spermogonia of this species are conical with a flat, basal, sporogenous layer. While there is no clue to the telial stage it is undoubtedly not *Puccinia* or *Uromyces*.

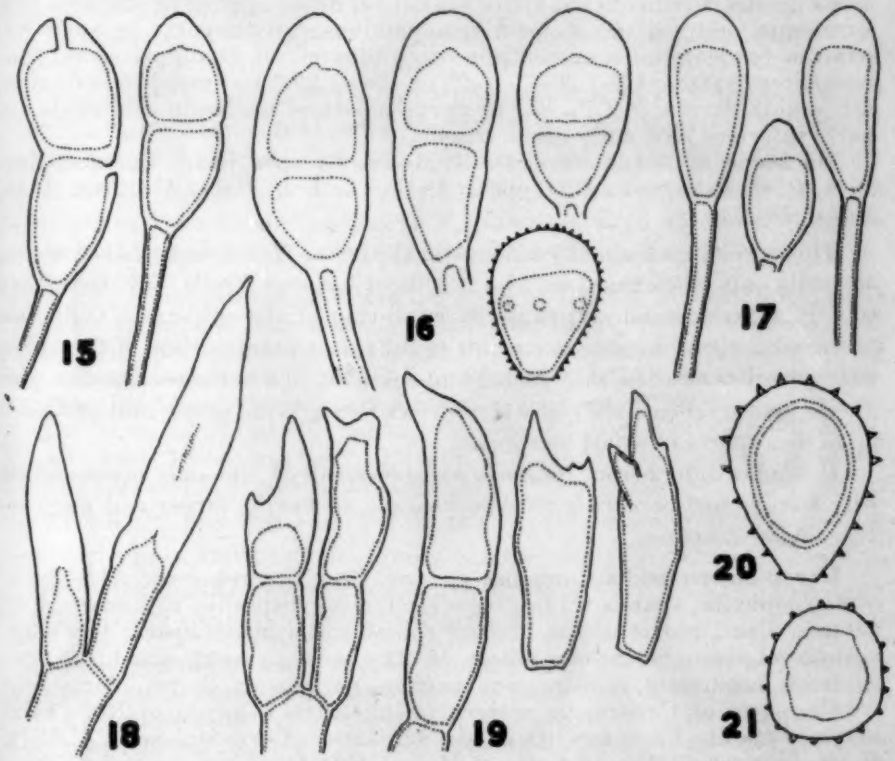
Uraecium carpodini differs markedly from *Uredo carpodini* P. Henn. because of the thickness of the wall and its bilaminate nature. It may be very near to *Uredo clitandri* P. Henn., described on *Clitandra* from Usambara, but the description makes no mention of spermogonia.

Uraecium magnisporum Cummins, sp. nov. Spermogoniis epiphyllis in maculis flavidis vel brunneis usque 5 mm. diam. aggregatis, subcuticularibus, applanatis vel lenticularibus, 40–50 μ altis, 125–175 μ latis, eparaphysatis. Aeciis circum spermogoniis aggregatis, amphigenis, subepidermalibus, epidermide rupta cinctis, cinnamomeis, pulverulentis, uredinoideis; aeciosporae variabiles, plerumque ellipsoideae vel elongato-ellipsoideae, rarius obovatae vel piriformibus, (19–) 23–29 (–31) × 36–56 (–60) μ vel rarius longiores; membrana 3–3.5 μ cr., aureo-brunnea vel pallide cinnamomeo-brunnea, valde echinulata, aculeae inter se 4–6 μ, poris germ. obscuris, verisimiliter 7–10, sparsis.

On leaves of *Croton ? macrostachys* Hochst., Kiambu, Kenya, Oct. 1938, *R. M. Nattrass 1006* Type! (A. H., C. M. I., S. Af., U.S.D.A.).

The only rust which is at all like this species is *Schroeteriaster doidgeae*

Syd. in South Africa for which only uredia are known. It has spores which are smaller (20–30 × 35–46 μ) and are described as having four equatorial pores. No spermogonia are mentioned. The pores in *U. magnisporum* are very difficult to observe but appear to be numerous and either widely scattered in shorter spores or in the equatorial region in long spores. Both rusts may prove to be species of *Bubakia*.



FIGS. 15–21. FIG. 15. Two teliospores of *Puccinia guizotiae* Cumm., a microcyclic species. (From type.) FIG. 16. Three teliospores and one urediospore of *Puccinia wichei* Cumm. (From type.) FIG. 17. Three teliospores of *Uromyces kigesianus* Cumm., a microcyclic species (From type.) FIG. 18. Paraphyses of *Uraecium africanum* Cumm. Note the very thick apical wall. (From type.) FIG. 19. Two urediospores (right) and three paraphyses (left) of *Uredo stenochlaenae* Cumm. It is possible that the structures designated as paraphyses may be teliospores. (From type.) FIG. 20. One aeciospore of *Uraecium carpodini* Cumm., showing the thick laminate wall. (From type.) FIG. 21. One urediospore of *Uredo mckinleyensis* Cumm. The species will prove to belong in the genus *Melampsora*. (From type.) × 800.

Uredo aburiensis Cummins, sp. nov. Urediis hypophyllis, sparsis vel laxe aggregatis, pulverulentis, cinnamomeo-brunneis, 0.1 mm. diam.; urediosporae ellipsoideae vel obovoideae, 17–22 × 26–33 (– 35) μ; membrana 1.5 μ cr. vel ad apicem frequenter 3 μ cr., moderate echinulata, pallide cinnamomeo-brunnea, poris germ. obscuris.

On leaves of *Lannea acidissima* A. Chev., Aburi, Gold Coast, Aug. 30, 1937, *F. C. Deighton CB952* Type! (A. H., C. M. I., S. Af.).

This species is similar to *Cerotelium proximellum* Syd. but the urediospores are shorter. *Cerotelium lanneae* (Höhn.) Arth. has smaller spores and, in addition, an uredial peridium.

Uredo alafiae Cummins and Gopalkrishnan sp. nov. Spermogoniis et aeciis ignotis. Urediis hypophyllis, sparsis vel dense aggregatis, flavidis, pulverulentis, minutis, per stomata erumpentibus; urediosporae in apice hypharum fasciculatim erumpentium ortis, plus minus triangulares vel unilateraliter ovatae, (16–) 20–27 (–29) × (26–) 29–34 μ; membrana hyalina vel pallide flavida, 2–2.5 μ cr., in parte superiore moderate echinulata, in parte inferiore levi, poris germ. obscuris.

On leaves of *Alafia clusioides* S. Moore, Entebbe Road, Uganda, Mar. 1944, *C. G. Hansford 3450* Type! (A. H., C. M. I., U.S.D.A.), Aug. 1944, *Hansford 3554*.

This species undoubtedly belongs in the genus *Hemileia* but since names are valid only when based on telia it is described as a *Uredo*. The uredia are strictly superstomatal and cause no rupturing of the epidermis. Only two or three "feeder" hyphae contribute to the substomatal portion of the sorus, which consists of a few thin-walled bulbous cells. The bulbous cells each produce a sporogenous stalk cell which grows through the stoma and produces numerous spores on short sterigmata.

U. alafiae differs from *Hemileia holarrhenae* Syd., the only other species with similar sori occurring on Apocynaceae, in having larger and more irregular urediospores.

Uredo calotropsidis Cummins, sp. nov. Urediis amphigenis vel plerumque hypophyllis, sparsis vel in greges circinatum dispositis, rotundatis, 0.3–1.0 mm. diam., pulverulentis, obscure cinnamomeis; urediosporae late ellipsoideae vel plus minusve obovoideae, 19–23 × 24–30 μ; membrana 1.5–2 μ cr., moderate echinulata, cinnamomeo-brunnea, poris germ. 3, aequatorialibus.

On leaves of *Calotropsis procera* (Ait.) R. Br., canyon of Rio Chicamocha, opposite Pescadero, Dept. de Santander, Colombia, Sept. 1, 1944, *H. St. John 20723* Type! (A. H., C. M. I., U.S.D.A.).

The uredia, while often scattered singly, seem more often to be arranged in a single ring around a central sorus. No rust has been reported on *Calotropsis* and no asclepiadaceous rust has such uredia and urediospores.

Uredo chlorophorae Cummins, sp. nov. Urediis hypophyllis, sparsis vel aggregatis, subepidermalibus, rotundatis, minutis, 100–170 μ diam., peridio tenui, aureo-brunneo ex cellulis plus minus cuboideis composito; urediosporae ellipsoideae vel obovoideae, 12–16 × 15–20 μ; membrana flavidula vel hyaline, 1 μ cr., minute densique echinulata, poris germ. obscuris.

On leaves of *Chlorophora regia* A. Chev., Kowama, Sierra Leone, Nov. 25, 25, 1949, *F. C. Deighton 3350* Type! (A. H., C. M. I.).

The uredia are formed between the mesophyll and the epidermis and

develop a thin golden peridium. No species described on the Moraceae has such sori or such small urediospores.

Uredo jeffersii Cummins, sp. nov. Urediis hypophyllis, laxe aggregatis, plus minusve rotundatis, 0.1–0.5 mm. diam., flavidis, pulverulentis, intraepidermidalibus, epidermide valde incrassata; urediosporae ellipsoideae, oblongo-ellipsoideae, vel obovoideae, 15–22 × (24 –) 26–31 (–36) μ; membrana hyalina, minute verrucoso-echinulata, 2–3 μ cr., ad apicem 7–12 μ cr., poris germ. obscuris, verisimiliter bizonatis.

On leaves of *Rubus* sp., near Merida, Venezuela, July 30, 1949, *W. F. Jeffers 131* Type! (A. H., U.S.D.A.)

This *Uredo* is typical of the intraepidermal species of *Mainsia*, the sori forming in the much thickened epidermis. *U. jeffersii* is similar to *Mainsia standleyi* Cumm., a rust in which uredia are as yet unknown. The urediospores of *U. jeffersii* are more finely marked, with the aculeae being short blunt cones, than the aeciospores of *M. standleyi*. Both are about the same size and both have an apical wall similarly thickened.

Uredo maschalocephali Cummins, sp. nov. Urediis hypophyllis, sparsis vel laxe aggregatis, rotundatis, 0.2–0.5 mm. diam., pulverulentis, cinnamoneo-brunneis, epidermide conspicue rupta; urediosporae ellipsoideae vel late ellipsoideae, 16–20 × 20–26 μ; membrana 1.5–2.5 μ cr., cinnamomeo-brunnea, moderate verrucoso-echinulata, poris germ. 2, aequatorialibus.

On leaves of *Maschalocephalus dinklagei* Gilg. & K. Schum., Tawata, Boporo Distr., Western Prov., Liberia, Nov. 14, 1947, *J. T. Baldwin Jr. 10290A* Type! (A. H., C. M. I., U.S.D.A.).

This is the first rust recorded on the Rapateaceae and *W. dinklagei* is the only representative of the family outside of South America (Baldwin, Amer. Jour. Bot. **37**: 402–405. 1950). Baldwin reports (*in litt.*) that some populations of the plant are severely rusted.

Uredo mckinleyensis Cummins, sp. nov. (fig. 21). Urediis hypophyllis, sparsis vel laxe aggregatis, rotundatis, 0.2–0.8 mm. diam., flavidis, compactis; paraphysibus copiosis, hyalinis, capitatis, 20–35 μ latis, usque 100 μ longis, membrana usque 8 μ cr.; urediosporae late ellipsoideae vel globosae, 20–24 × 21–29 μ; membrana hyalina, 3.5–5.5 μ cr., moderate verrucoso-echinulata, poris germ. obscuris, sparsis.

On leaves of *Salix reticulata* var. *gigantifolia*, McKinley Park, Alaska, July 16, 1948, *C. Le Febvre 97* Type! (A. H., U.S.D.A.).

This rust is most like *Melampsora reticulata* Blytt of any described species but has urediospores with much thicker walls and more loosely arranged aculeae. In *U. mckinleyensis* the aculeae are low fairly sharp cones spaced at intervals of 3 μ. The paraphyses and urediospores are borne on well-developed, laterally free sporogenous basal cells, a characteristic not previously observed in *Melampsora*.

Uredo monechmae Cummins, sp. nov., Urediis amphigenis sed praecipue hypophyllis in gregibus circinatis 1–3 mm. dispositis, subepidermalibus,

pulverulentis, cinnamomeo-brunneis, epidermide conspicue rupta, peridio hyalino ex cellulis polygonalibus 9–14 μ diam. composito; urediosporae plerumque ellipsoideae, 15–19 × 21–30 (–33) μ; membrana minute echinulata, flavida vel pallide flavo-brunnea, 1–1.5 μ cr., poris germ, obscuris, verisimiliter 4 vel 5, aequatorialibus.

On leaves of *Monechma subsessile* C. B. Clarke, Mbarara Road, Uganda, Sept. 1944, *C. G. Hansford 3585* Type! (A. H., C. M. I., U.S.D.A.).

Uredo myopori Cummins, sp. nov. Urediis amphigenis, sparsis vel laxe aggregatis, subepidermalibus, plus minus rotundatis, usque ad 1.3 mm. diam., pulverulentis, obscure cinnamomeo-brunneis, epidermide conspicue rupta; urediosporae variabiles, plerumque ellipsoideae vel obovoideae, 20–28 × (26–) 29–37 (–40) μ; membrana echinulata, 2.5–3 μ cr., poris germ, variabilibus, (2–) 3–4 (–6), plerumque plus minus aequatorialibus.

On leaves of *Myoporum sandwichense* Gray, Parker Ranch, Humuula Road, N. Hilo Distr., Hawaii, Hawaii, Dec. 26, 1946, *D. P. Rogers 3183* Type! (A. H., N. Y.).

This and *Aecidium myopori* Cunn., in New Zealand, are the only rusts recorded on the Myoporaceae.

Uredo stenochlaenae Cummins, sp. nov. (fig. 19). Urediis epiphyllis, subepidermalibus, plus minusve rotundatis, 0.2–0.4 mm. diam., pallide flavidis, peridio flavidulo ex cellulis polyhedricis vel isodiametricis composito, membrana 2–3 μ cr.; urediosporae valde variabiles, plerumque plus minus oblongae, apicem versus acuminatae, apiculatae, digitatae, vel lobatae, 11–16 × (40–) 45–56 μ; membrana hyalina, 1–1.5 μ cr., ad apicem 3–8 μ cr., laevi, poris germ. non visis. Paraphysibus (vel teliosporae ?) frequenter copiosis, bicellularibus, puccinioideis, elongatis, utrinque attenuatis vel ad apicem digitatis, 11–17 × 56–90 (–112) μ, sessiles, membrana hyaline, 1.5–2 μ cr., ad apicem usque ad 24 μ incrassata.

On leaves of *Stenochlaena vestita* (Fourn.) Underw., Dept. Morazan, Cerro de Uyuco, Honduras, Mar. 2, 1947, *P. C. Standley 4803* Type! (A. H., U.S.D.A.).

This is an interesting rust of uncertain relationship. When first examined, because of the colorless spores and the peridium which is closely adherent to the epidemis, it was thought to be a species of *Uredinopsis*. Additional study revealed the presence, in some but not all sori, of the puccinioid paraphyses or teliospores. These are often abundant and appear to be the only structures present in some sori. This would indicate that they may be teliospores. On the other hand, most of them have little or no cytoplasm yet apparently have not germinated, indicating that they are not spores. If they are paraphyses one would expect to find them in all sori, which is not the case. Because of this uncertainty and since no established genus could accommodate such a rust the species is tentatively placed in *Uredo*.

UREDO WANTOATENSIS Cumm. (Mycologia **33**: 153. 1941). On *Impatiens* sp., Wantoat, New Guinea, Jan. 9, 1940, *M. S. Clemens 10944A* Type!

This species should be reduced to synonymy under *Uredo gäumannii* Ed.

Fischer (Ber. Schw. Bot. Gaz. **47**: 424. 1937), a species described from Java on *Impatiens platypetala*.

Uromyces kigesianus Cummins, sp. nov. (fig. 17). Spermogoniis, aeciis, et urediis ignotis. Teliis hypophyllis in maculis brunneis leniter incrassatis usque ad 3 mm. diam. dense aggregatis vel confluentibus, pulvinatis, castaneo-brunneis; teliosporae ellipsoideae, obovatae vel oblongo-ellipsoideae, ad apicem rotundatae, ad basim plerumque attenuatae, 13–19 (–24) × 30–40 (–43) μ; membrana aureo- vel pallide castaneo-brunnea, 2–2.5 μ cr., ad apicem 6–12 μ, levi; pedicello persistenti, pallide flavido, usque ad 80 μ longo. Statim germinantibus.

On *Pittosporum abyssinicum* Delile, Rubaya, Kigesi, Uganda, July 1945, *C. G. Hansford 3696* Type! (A. H., C. M. I., U.S.D.A.).

There have been few rusts collected on the Pittosporaceae and none similar to *U. kigesianus*. *Uromyces pittospori* P. Henn. is only a *Uredo* according to Sydow (Ann. Mycol. **6**: 140. 1908). Although it was reported on the same host it cannot be the same organism as *U. kigesianus*, which obviously is microcyclic.

Uromyces rhinacanthi Cummins, sp. nov. (fig. 12). Spermogoniis non visis. Aeciis hypophyllis in maculis rufo-brunneis usque 6 mm. diam. aggregatis, cupulatis, 0.2 mm. diam., margine lacerato; cellulis peridii polyhedricis vel ellipsoideis, 13–19 × 20–28 μ, verrucosis; aeciosporae late ellipsoideae vel globosae, 12–15 × 14–18 μ; membrana hyalina, minuteque verruculosa, 1 μ cr. Urediis nullis. Teliis circum aecia aggregatis, subepidermalibus, atro-brunneis, indehiscentibus, loculatis, loculis individuis usque 170 μ diam., paraphysibus numerosis brunneis coalitis; teliosporae valde variabiles, ellipsoideae, oblongae, vel clavatae, ad apicem rotundatae, obtusae, vel acuminatae, basim versus attenuatae, 15–19 × 29–43 μ; membrana 1.5–2 μ cr., ad apicem 3–6 μ cr., pallide castaneo-brunnea vel deorsum aureo-brunnea; pedicello brunneo, persistenti, 25–50 μ longo.

On leaves of *Rhinacanthus nasutus* (L.) Kuntze, Kpeve, Togoland, West Africa, Jan. 20, 1948, *N. F. Robertson* (comm. H. Owens No. 592) Type! (A. H., C. M. I.).

No species of *Uromyces* having such loculate telia has been described on Acanthaceae but there are several species of *Puccinia* of generally similar morphology.

Uromyces wiehei Cummins, sp. nov. Spermogoniis et aeciis ignotis. Urediis hypophyllis, sparsis vel laxe aggregatis, flavo-brunneis, rotundatis, 0.15–0.2 mm. diam., paraphysibus copiosis, lenissime vel valde capitatis, usque ad 20 μ latis et 65 μ longis, hyalinis vel pallide flavidis, membrana uniformiter 1 μ cr.; urediosporae late ellipsoideae vel subglobosae, 16–20 × 19–26 μ; membrana flavo-brunnea vel fere hyalina, 1 μ cr., minuteque echinulata, poris germ. 6–8, sparsis. Teliis hypophyllis, plus minus rotundatis, atro-brunneis, indehiscentibus, loculatis, loculis individuis 40–84 μ diam., paraphysibus numerosis brunneis coalitis; teliosporae subgloboideae, ellipsoideae, obovoideae, vel oblongatae, 14–17 × 18–23 μ; membrana castaneo-

brunnea, 1.5–2 μ cr. vel ad apicem usque 3 μ incrassata; pedicello hyalino, semipersistenti, usque ad 30 μ longo.

On leaves of *Thalictrum rhynchocarpum* Dill. & A. Rich., Zomba plateau, Nyasaland, Feb. 20, 1949, *P. O. Wiehe 22* Type! (A. H., C. M. I., S. Af., Stock.); Zomba Mt., Nyasaland, Aug. 21, 1950, *Wiehe 841.*

No species of *Uromyces* has been reported previously on the genus *Thalictrum* and only a few species are known to parasitize the Ranunculaceae as their telial host. *U. fischerianus* Mayor, on species of *Ranunculus*, has similar telia but the uredia lack paraphyses.

Uromyces wolfii Cummins, sp. nov. (fig. 13). Spermogoniis, aeciis, et urediis ignotis. Teliis amphigenis in maculis pallidis laxe aggregatis vel plus minusve circinatim dispositis, atro-brunneis, pulverulentis, usque ad 1.0 mm. diam.; teliosporae ellipsoideae, obovoideae, vel globoideae, (23–) 26–29 × (29–) 33–40 (–48) μ; membrana castaneo-brunnea, moderate et laxe papillato-verrucosa, 3–3.5 μ cr., ad apicem umbonata 6–10 μ cr.; pedicello hyalino, fragili, usque ad 19 × 40 μ, basim versus ruguloso.

On leaves of *Borreria laevis* (Lam.) Griseb., Rancho Grande, Venezuela, Feb. 16, 1948, *F. A. Wolf 3* Type! (A. H., C. M. I., U.S.D.A.).

This rust is distinct from most rubiaceous species of *Uromyces* in having verrucose teliospores. This characteristic separates *U. wolfii* from *U. spermacoces* (Schw.) Curt., *U. holmbergii* Speg., and *U. cruchetii* Mayor, which parasitize closely related hosts. The species has somewhat similar but considerably smaller teliospores and entirely different pedicels than those of *U. bouvardiae* Syd.

THE ARTHUR HERBARIUM,
PURDUE UNIVERSITY AGRICULTURAL EXPERIMENT STATION
LAFAYETTE, INDIANA

BULLETIN OF THE TORREY BOTANICAL CLUB
VOL. 79, NO. 3, PP. 235–241 MAY, 1952

RETARDATION IN CELL DEVELOPMENT IN LEAF AND FLOWER BUDS OF PHASEOLUS VULGARIS L. FROM FOLIAR APPLICATIONS OF MALEIC HYDRAZIDE[1]

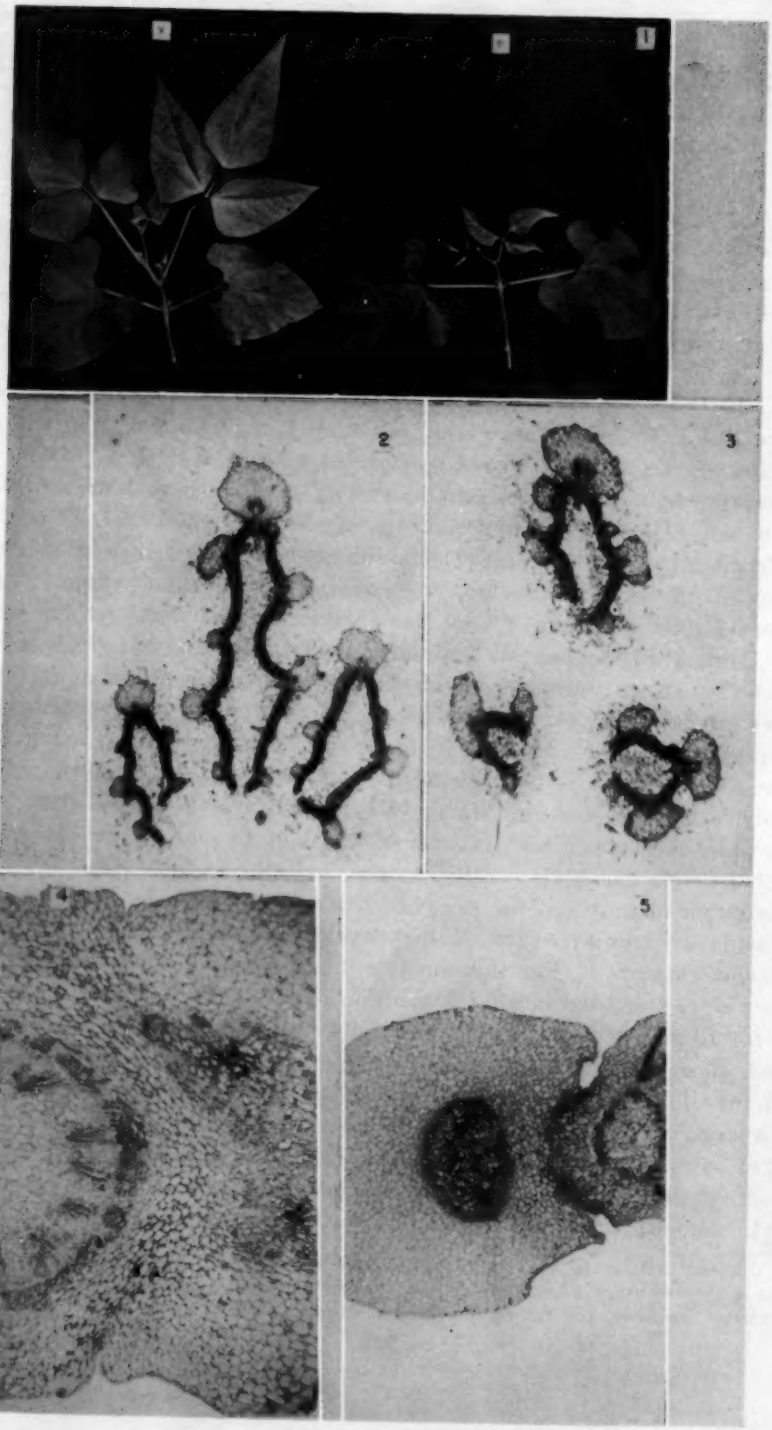
DONALD P. WATSON

Plants sprayed with maleic hydrazide have been shown to exhibit symptoms of growth regulator injury. These effects are varied and apparently depend upon the concentration of the material and the stage of development of the plant at the time of treatment (Crafts, Currier and Day 1950, Naylor 1950, Naylor & Davis 1950). Inhibition of growth has been shown in: *Sorghum, Echinochloa,* (Crafts, Currier and Day 1950, Currier & Crafts 1950); *Malus, Prunus, Vaccinium* (Fillmore 1950, Tukey & White 1950); *Pyracantha* (Knott 1950); *Ginkgo, Catalpa* (Miller & Erskine 1949); *Zea, Helianthus, Lycopersicum, Arachis, Nicotiana, Xanthium* (Naylor 1950); *Allium,* and *Daucus* (Wittwer, Sharma, Weller and Sell 1950). This inhibition frequently takes the form of delaying or preventing the development of flowers of: *Nicotiana* (Naylor 1950), *Rosa, Forsythia* (Fillmore 1950), *Ginkgo* (Miller & Erskine 1949); *Zea* (Naylor 1950); *Lycopersicum* (Naylor & Davis 1950, Schoene & Hoffmann 1949); and *Rubus* (White & Kennard 1950). Other more specific effects are: production of sterile staminate flowers on *Zea* (Naylor 1950); shifting of the critical daylength of *Xanthium* (Naylor 1950) destruction of apical dominance of *Xanthium* and *Pisum* (Naylor & Davis 1950); alteration of the quantity of chlorophyll and size of leaves of *Pisum* and *Malus* (Naylor & Davis 1950, Tukey & White 1950); and increase in the diameter of stems of *Lycopersicum, Gossypium, Xanthium* (Naylor & Davis 1950).

The major objective of the present work was to study the effect of maleic hydrazide on the structure of the developing parts of the bean plant, *Phaseolus vulgaris* L. For this purpose one hundred seeds of the var. Red Kidney were sterilized in a 0.1% solution of Kromet (Wyandotte Chemical Co.) for 10 minutes. The seeds were transferred under sterile conditions to 250 ml. glass jars (one seed per jar) each of which contained sterile agar to the depth of 20 mm. (7.5 gms. agar, 1000 ml. distilled water, autoclaved before seeding at 15 lbs. pressure for 15 min.). Germination took place in the dark at 28° C. Ten days later fifty bean plants were selected for uniformity in bud length and the excess agar was removed from their roots. The plants were then grown singly in 250 ml. glass bottles each of which contained 30 ml.

[1] Journal Article 1226 from the Michigan Agricultural Experiment Station. The author wishes to express his appreciation to E. F. Oakberg, U.S.D.A. Regional Poultry Laboratory, Lansing, for taking the photomicrographs.

UNIVERSITY OF MICHIGAN LIBRARIES


2
3
4
5

of Detmer's nutrient solution. They were supplied with 700 foot candles of continuous fluorescent light and maintained at approximately 20° C. More nutrient solution was added from time to time to replace that lost by absorption and evaporation. Plants were selected so that terminal buds on all plants were from 3–4 mm. in length. The measurements were made from the base of the stipules at the base of the bud to the tip. When there was curvature in this bud, the measurement was made in the same manner ignoring the curvature. One half of the plants were sprayed with a solution of maleic hydrazide (500 ppm. of the active ingredients of the diethanolamine formulation) one day after being transferred to the nutrient solution and continuous light. Care was taken to prevent any of this material from running down the stem into the nutrient solution.

Within a few days following treatment, there was a noticeable reduction in growth of the treated plants. After fifteen days the untreated plants (fig. 1X had unfolded three trifoliolate leaves, the first one of which was fully expanded. No trifoliolate leaves were fully expanded on the treated plants (fig. 1B). The first two trifoliolate leaves had unfolded, but each leaflet was either rolled from the margin toward the mid-rib or was somewhat misshapen. Flower buds were visible at the second, third, and fourth nodes of the untreated plants. No flower buds were visible on any of the treated plants. Plants sprayed with 500 ppm. of maleic hydrazide, when buds were smaller or with a higher concentration when the terminal buds were from 3–4 mm. in length, consistently exhibited early abscission of terminal buds and individual leaves if they had already expanded. After this happened, lateral growth from the first node was rapid and all of the parts on the stems that development were normal. On all treated plants the entire, primary leaves were a darker green than comparable leaves on the untreated plants.

In order to compare the development of an individual leaf from a treated and untreated plant, two terminal buds were collected from the two series zero, five, and ten days after treatment. Permanent microscopic sections were made by the usual paraffin method. Sections were made ten microns in thickness and stained with Delafield's haemotoxylin and safranin.

In general the most conspicuous result of the treatment was a reduction in size of the plants. The trifoliolate leaves were numbered from the primary pair of leaves at the base of the plant toward the apex. Figures 2 and 3 are photomicrographs of a section from the second trifoliolate leaf of

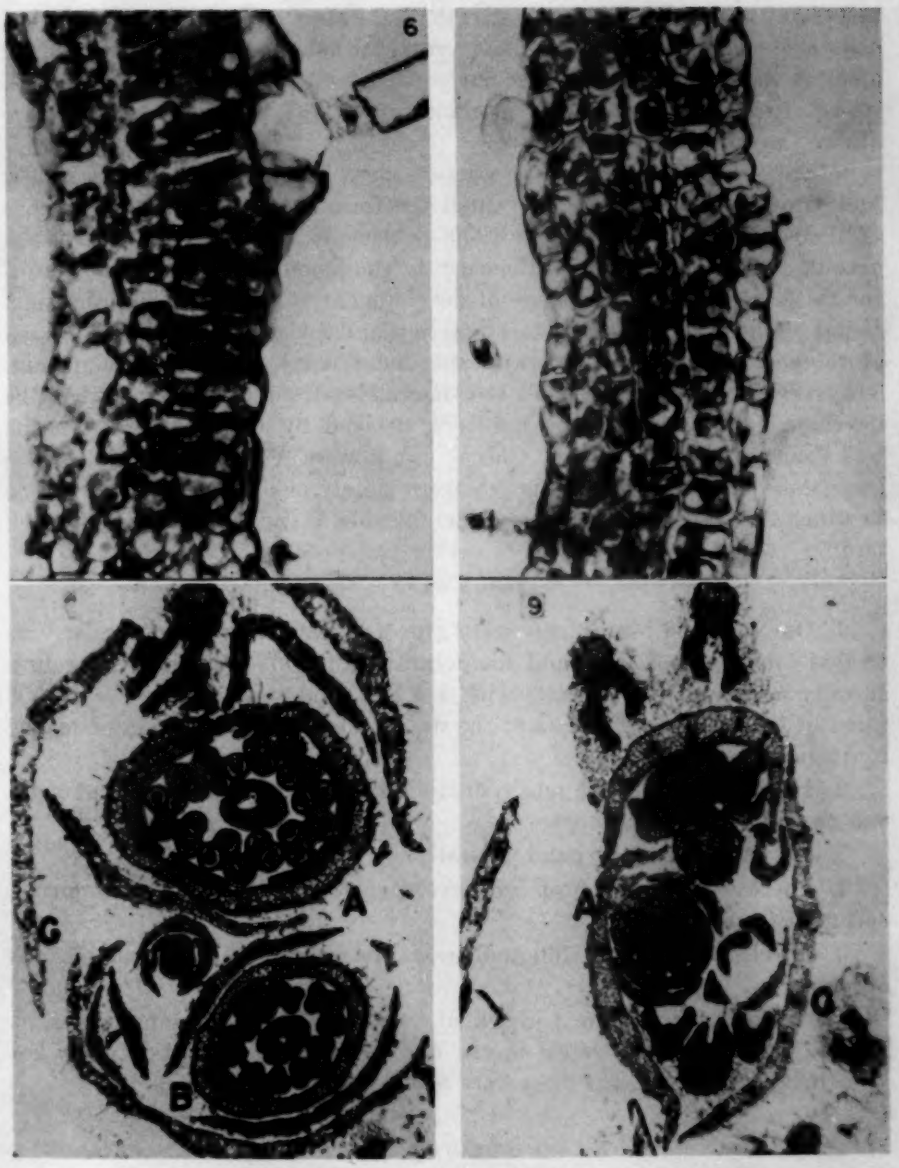
FIGS. 1–5. FIG. 1. X, untreated plant; B, treated plant (both 15 days after treatment). FIG. 2. Transverse section of second trifoliolate leaf from untreated plant, (10 days after treatment) ×18. FIG. 3. Transverse section of second trifoliolate leaf from treated plant, (10 days after treatment) ×18. FIG. 4. Transverse section of stem at node showing abscission zone in untreated plant, (10 days after treatment) ×18. FIG. 5. Transverse section of stem at node showing abscission zone in treated plant, (10 days after treatment) ×18.

UNIVERSITY OF MICHIGAN LIBRARIES

an untreated and treated plant, respectively, ten days after treatment. The leaf from the treated plant (fig. 3) has failed to extend laterally, and is less mature. While the veins have reached a comparable stage of development, interveinal tissue in general has not developed accordingly. The fragments along both surfaces of all leaflets are parts of the many hairs that are conspicuous in the bud before the leaf has completely unfolded and expanded. There is consistent failure of leaves on treated plants to develop as rapidly as those on untreated plants. This makes it possible to locate in a bud from an untreated plant, a leaf that is at a stage of development corresponding to another leaf in a bud from a treated plant. This leaf of an untreated plant would be much younger, and at a location on the stem closer to the apex of the stem.

Figure 6 is a photomicrograph of a cross section of the central leaflet of the second trifoliolate leaf for comparison with a cross section of a similar leaf (fig. 7) ten days after the plant was treated with maleic hydrazide. Both of these leaves were of comparable age and size at time of treatment. Close examination reveals that the treatment has caused inhibition in cellular enlargement. The epidermal cells are in similar number but they are smaller in the leaflet from the treated plant (fig. 7). Palisade parenchyma is difficult to identify. Cells of this layer are slightly elongated, but are almost isodiametric in contrast to typical elongated palisade cells (fig. 6). There are approximately the same number of chloroplasts in all of the cells of the spongy parenchyma of the leaf from the treated plant but the chloroplasts are smaller and less in number than in the palisade cells of the leaf of the untreated plant. A view of the base of one of the many epidermal hairs is found in the illustration of the leaf from the untreated plant (fig. 6). There are few, if any, intercellular spaces in the spongy parenchyma of the leaf from the treated plant. No apparent abnormal cell division, typical of that caused by 2,4-D (Watson 1948) is found. The leaf from the treated plant is merely in a stage of development that one would expect to have been reached about six days earlier if it had not been treated. This inhibition in cell enlargement is in contrast to inhibition of cell division as shown in *Allium* roots by Greulach and Atchison (1950). The different response may be explained on the basis of age of cells at time of treatment, concentration of maleic hydrazide used, or a different response of the bean.

While increase in stem diameter of *Lycopersicum* and *Xanthium* takes place following treatment with maleic hydrazide (Naylor and Davis 1950), *Phaseolus* did not show this type of growth. Twenty days after treatment there was abscission of nearly all parts that became visible following treatment. Ten days after treatment samples were taken. Serial sections were made of the first nodal region for the purpose of studying the zone where the petiole joins the stem. Figures 4 and 5 show a transverse section of stems of untreated and treated plants respectively. It is quite apparent that the



FIGS. 6–9. FIG. 6. Transverse section of second trifoliolate leaf blade from untreated plant, (10 days after treatment) ×480. FIG. 7. Transverse section of second trifoliolate leaf blade from treated plant, (10 days after treatment) ×480. FIG. 8. Transverse section of bud from untreated plant showing: A and B flowers, C. stipules, (10 days after treatment) ×480. FIG. 9. Transverse section of bud from treated plant showing: A, immature flower and C stipules, (10 days after treatment) ×480.

treatment has inhibited overall growth of the stem and petiole. The cortical cells are smaller and the abscission zone, although distinguishable in the stem of the untreated plant, is not in as advanced a stage. There is evidence of an increased rate of abscission in all the treated plants that are allowed to continue to grow.

Much evidence has been presented to show that treatments with maleic hydrazide have delayed or prevented the formation of reproductive parts (Miller & Erskine 1949, Naylor 1950, Schoene & Hoffmann 1949). The degree of inhibition has been influenced by the amount and concentration of the material used, and the stage of development at the time of application. Using plants with a 3–4 mm. terminal bud and a concentration of 500 ppm. of the chemical on beans in this experiment delayed flower development. Transverse sections of the bud ten days after treatment showed that the development of flower parts has been delayed by the treatment. In the bud from the untreated plant (fig. 8) two flowers A & B are found. In the bud from the treated plant (fig. 9) there is only one, less mature flower A, in which the stamens are not yet clearly visible. C indicates stipules in each bud.

SUMMARY

1. One hundred bean plants were grown in nutrient solution under controlled conditions of light and temperature. Plants were selected for uniformity and twenty-five plants with 3–4 mm. buds were sprayed with 500 ppm. of the active ingredients of the diethanolamine formulation of maleic hydrazide.

2. Inhibition of growth and reduction of size of all above ground parts was caused by this treatment.

3. Leaves failed to expand laterally.

4. There was inhibition of cell development but no apparent abnormal cell multiplication.

5. Abscission of parts, followed by rapid growth of axillary buds was observed.

6. Abscission zones in petioles of treated plants developed rapidly. Reproductive parts developed in the bud before abscission took place but were delayed in their growth as were leaves and stems.

Literature Cited

Crafts, A. S., Currier, H. B. & Day, B. E. 1950. Response of several crop plants and weeds to maleic hydrazide. Hilgardia **20**: 57–80.

Currier, H. B. & Crafts, A. S. 1950. Maleic hydrazide, a selective herbicide. Science **111**: 152–153.

Fillmore, R. H. 1950. The control of plant development with maleic hydrazide. Arnoldia **10**: 33–39.

Greulach, V. & Atchison, E. 1950. Inhibition of growth and cell division in onion roots by maleic hydrazide. Bull. Torrey Club **77**: 262–267.

Knott, J. E. 1950. The use of maleic hydrazide for controlling the growth of a Pyracantha hedge. Proc. Am. Soc. Hort. Sci. **55**: 504–506.

Miller, R. R. & Erskine, D. 1949. The prevention of fruit formation on some ornamental trees. Proc. 25th Nat. Shade Tree Conference: 88–100.

Naylor, A. W. 1950. Observations on the effects of maleic hydrazide on the flowering of tobacco, maize and cocklebur. Proc. Nat. Acad. Sci. **36**: 230–232.

Naylor, A. W. & Davis, E. A. 1950. Maleic hydrazide as a plant growth inhibitor. Bot. Gaz. **112**: 112–126.

Schoene, D. L. & Hoffmann, O. L. 1949. Maleic hydrazide, a unique growth regulant. Science **109**: 588–590.

Tukey, Loren & White, D. G. 1950. Retardation of development of several fruit crops by introduction of maleic hydrazide. Private correspondence. Penn. State College.

Watson, Donald P. 1948. An anatomical study of the modification of bean leaves as a result of treatment with 2,4-D. Am. Jour. Bot. **35**: 543–555.

White, David G. & Kennard, W. C. 1950. A preliminary report on the use of maleic hydrazide to delay blossoming of fruits. Proc. Am. Soc. Hort. Sci. **55**: 147–151.

Wittwer, S. H., Sharma, R. C., Weller, L. E. and Sell, H. M. 1950. The effect of pre-harvest foliage sprays of certain growth regulators on sprout inhibition and storage quality of carrots and onions. Plant Physiol. **25**: 53a–54a.

BULLETIN OF THE TORREY BOTANICAL CLUB
Vol. 79, No. 3, pp. 242–250 May, 1952

INHIBITION AND ENHANCEMENT OF THE GROWTH OF FUNGI WITH STREPTOMYCIN

John B. Loefer, F. W. Bieberdorf and R. G. Weichlein

Growth of many bacteria is inhibited by streptomycin. Some species are extremely sensitive to this antibiotic and susceptible to as little as one microgram or less per milliliter, e.g., *Escherichia coli, Brucella suis, Pasteurella tularensis, Eberthella typhosa, Pseudomonas aeruginosa, Bacillus subtilus* and *Staphlococcus albus*. Although most bacteria are not so sensitive, in general, those species which are inhibited usually respond to concentrations under several hundred micrograms per milliliter of medium (Morgan, Hunt, Kent and Carlisle 1947).

Enhancement of growth by streptomycin has also been reported for a number of bacteria, e.g., *Mycobacterium tuberculosis* (Spendlove, Cummings, Fackler, Jr. and Michael, Jr. 1948); the streptomycin-requiring meningococcus (Miller and Bonhoff 1947, Rake 1948), *E. coli* (Rake 1948), *Staph. aureus, E. Coli, Ps. aeruginosa, Proteus morgani* (Paine and Finland 1948), a gram-negative bacillus, strain SMR (Hobby and Dougherty 1948), and a number of sporogenic and nonsporogenic bacteria (Curran and Evans 1947).

Carvalho (1949) reported that streptomycin concentrations of 0.3–1% in tissue culture stimulated both growth and oxygen consumption of embryonic chick tissues.

On the other hand, large amounts of streptomycin are required to inhibit growth of fungi. Robinson, Smith and Graessle (1944), and Robinson (1946) reported that streptomycin concentrations of 3.5–8.0 milligrams per milliliter were required to inhibit the growth of eleven species. In addition to the five species listed in table 3, these included *Epidermophyton inguinale, Microsporum canis, Trichophyton gypseum, T. interdigitale, Aspergillus niger* and *Penicillium chrysogenum*. Serri (1948), however, found that one microgram per 100 ml. in a glucose-peptone medium caused growth inhibition of *Achorion schoenleinii,* but this amount did not affect either *T. rosaceum* or *T. pedis.*

Some reports also show that streptomycin stimulates growth of fungi. Roessler, Herbst, McCullough, Mills and Brewer (1946) noted that streptomycin concentrations as high as 300 micrograms per milliliter stimulated growth of *Coccidioides immitis*. Campbell and Saslaw (1949) reported enhancement of growth of the following species: *Sporotrichum schenckii* (6 of 6 strains), *T. mentagrophytes* (1 strain), *Histoplasma capsulatum* (2 of 3 strains), *Coccidioides immitis* (4 of 4 strains) and *Phialophora verrucosa*

(1 strain). The stimulating effect was obtained at pH 4.6 and 8. Maximum growth resulted with 2.5 mgs. per ml. and the effect was obtained "only with young actively growing cultures and not with old stored suspensions." In a later report by these authors (1951) they stated that, "Although streptomycin may enhance the growth of the mycelial phase of *H. capsulatum in vitro* no increased virulence has been observed with *in vivo* studies employing the yeast phase of the fungus."

Materials and methods. In connection with our studies on growth and pigment discoloration of certain species of flagellated protozoa (Loefer, 1949) and fungi, we used the medium of Campbell and Saslaw (1949) along with others. Preliminary results of our investigations made on 17 species of pathogenic and nonpathogenic fungi were previously reported (Loefer, Bieberdorf, and Weichlein 1950).

Seventeen different strains (16 species) were used in this study. They are listed in table 1. The cultures were in most cases either isolated in this

TABLE 1. *Effect of streptomycin on fungi*

Pathogens			
Blastomyces dermatitidis	1	*Candida albicans*	1, 2, 4
Candida krusei	1	*Coccidioides immitis*	4
Histoplasma capsulatum	2, 4	*Cryptococcus neoformans*	1, 2, 4
Phialophora verrucosa	4	*Nocardia asteroides*	5
Trichophyton rubrum	1, 3	**Nocardia sp.* (Bloyer)	1, 2, 3, 4, 5
		Sporotrichum schenckii	2, 3, 4, 5
		Trichophyton mentagrophytes	2, 4
Non-Pathogens			
Aspergillus flavus	1	*Penicillium ochraceum*	1, 3
Fusarium sp.	3		
Spondylocladium australe	1		
Syncephalastrum racemosum	1, 3		

Numbers indicate experiments in which the species was used.

Left column lists species in which growth was unaffected; right column those in which growth was either accelerated or inhibited.

* Isolated from a brain lesion and closely resembles *N. asteroides.*

laboratory or obtained from patients at the Santa Rosa Hospital through the courtesy of Dr. S. W. Bohls. Other strains were kindly furnished by Dr. N. C. Conant of Duke University.

For experiments 1 and 2 the medium devised by Bieberdorf and Argabrite (1949)[1], containing 1% Bacto-peptone and 3% sucrose, was used. The inorganic medium of Campbell and Saslaw (1949)[2], containing 0.5% glucose, was used for experiments 3, 4 and 5. Bacto-peptone (1%) was added to those parts of experiment 5 designated in table 2.

[1] Contains the following inorganic salts in grams per liter: $NaNO_3$, 2.0; K_2HPO_4, 1.0; KH_2PO_4, 0.5; $MgSO_4$, 0.5; KCl, 0.5 and $FeSO_4$, 0.01.

[2] Contains the following salts: KH_2PO_4, 4.5 gm; $(NH_4)_2SO_4$, 0.5 gm; NH_4Cl, 0.5 gm; M/500 $Fe(NH_4)_2(SO_4)_2.6\ H_2O$ in N/50 HCl, 25 ml; 0.4% $MgSO_4.7\ H_2O$, 10 ml; distilled water, 1 liter.

Measured amounts of media were pipetted into 18 × 150 mm. Pyrex culture tubes and autoclaved. Streptomycin (Merck's calcium chloride complex) was dissolved in the ampoule with some of the sterile medium. It was withdrawn with a sterile syringe and added aseptically in appropriate amounts to the culture tubes to obtain either a given concentration (expt. 5) or a series of streptomycin concentrations (as in expts. 1, 2, 3 and 4) as follows: Controls with no streptomycin, 0.1, 1.0, 2.5, 5.0 and 10 milligrams per milliliter. Triplicate sets of these series were given loop inoculations from young cultures from each respective strain for the experiment concerned. Cultures were incubated in semi-darkness at 28° C. in a water bath (expts. 1, 2, 3, 4, and part of 5) or at room temperature (average 31°, range 27 to 34 ° C.) as in the duplicate of expt. 5. Periods of incubation varied from 10–27 days. Hydrogen-ion concentration of the cultures was determined with a Beckman glass electrode pH meter on samples taken after inoculation. Experiments were carried out at or near pH 4.0 or 6.0.

Amount of growth was estimated from macroscopic observation, and either inhibition or enhancement was quite discernible as the photographs indicate.

Results. In the left column of table 1 are listed nine species of fungi in which growth was neither inhibited nor enhanced in this series of experiments. The right column, however, lists seven species (8 strains) in which there was a marked relative difference between streptomycin-containing cultures and controls. Details of the cultural conditions and effects noted on the growth of this group are given in table 2.

Series 1 and 2 were similar in that a peptone medium at pH 6.0 was employed. Except that the pH was different in expts. 3 and 4, they were comparable in that the salt medium of Campbell and Saslaw (1949) was used.

In some cases, however, enhancement was obtained under one set of conditions; inhibition under another. The most obvious variables, other than the strains used, were the composition of the medium, its reaction, and the difference in incubation temperatures.

Series 5 showed that whether the temperature during incubation was held at 28° or 31° C., there was no appreciable effect on growth of either of the Nocardia strains or *Sporotrichum* with or without streptomycin. Growth at pH 4.0 was not as good as at 6.0 with or without peptone. *S. schenckii* was exceptional in that growth was excellent in both ranges.

The results on *Nocardia* sp. (Bloyer) were quite striking. In an organic medium at pH 6.0, (table 2, series 1, 2 and 5) there was progressive inhibition with increased streptomycin, and inhibition was also observed in series 5, both in the salt and peptone-containing cultures. Under ordinary growth conditions *Nocardia* sp. produces an orange pigment. Discoloration was

noted in cultures containing 2.5–10 mgs./ml. of streptomycin, although growth was abundant.

In series 3, at pH 4.1, however, there was progressive acceleration, with best growth at the 10 mg. streptomycin level (fig. 1). In series 4 no relative effect on growth was observed.

TABLE 2. *Effect of streptomycin on fungi*

Expts. 1–5. List of Conditions and Observed Effect on Growth

Species	Expt. No.	Streptomycin mgs./ml.	Type of Medium	pH	Effect Noted	Remarks
Nocardia asteroides	5	5	P	4.0	i	pC
	5	5	P	6.0	i	gC
	5	5	S	4.0	i	pC
	5	5	S	6.0	i	gC
Nocardia sp. (Bloyer)	1, 2	0.1–10	P	6.0	i	E, up to 2.5
	3	0.1–10	S	4.1	a	pC, E
	4	0.1–10	S	5.9	n	
	5	5	P	4.0	n	pC
	5	5	P	6.0	i	gC
	5	5	S	4.0	n	pC
	5	5	S	6.0	i	gC
Candida albicans	1, 2	0.1–10	P	6.0	i	E
	4	0.1–10	S	5.9	a	pC, E, best at 5
Cryptococcus neoformans	1, 2	0.1–10	P	6.0	i	E
	4	0.1–10	S	5.9	a	E, best at 5
Coccidioides immitis	4	0.1–10	S	5.9	a	g at 10
Sporotrichum schenckii	2	0.1–10	P	6.0	n	gC
	3	0.1–10	S	4.1	i	E, esp. at 10
	4	0.1–10	S	5.9	a	E, best at 10
	5	5	P	4.0; 6.0	n	gC
	5	5	S	4.0; 6.0	a	
Trichophyton mentagrophytes	2	0.1–10	P	6.0	i	E
	4	0.1–10	S	5.9	n	
Penicillium ochraceum	1	0.1–10	P	6.0	a	E
	3	0.1–10	S	4.1	n	

i = inhibition
a = acceleration
n = no relative effect
p = poor growth
g = good growth

C = controls
E = effect was progressive
P = peptone medium
S = salt medium, no peptone

An inhibition of growth of *Candida albicans* was noted in series 1 and 2, but in series 4 a progressive effect was observed and the best growth was obtained with 5 mgs. streptomycin per ml.

Inhibition of *C. neoformans* was also obtained with streptomycin in a peptone-containing medium (series 1 and 2); but enhancement occurred under other conditions (series 4).

Coccidioides immitis, used in series 4, exhibited better growth after 28 days with streptomycin than without.

No effect of streptomycin on *S. schenckii* was apparent when it was grown in organic media (table 2, series 2 and 5). In the inorganic medium

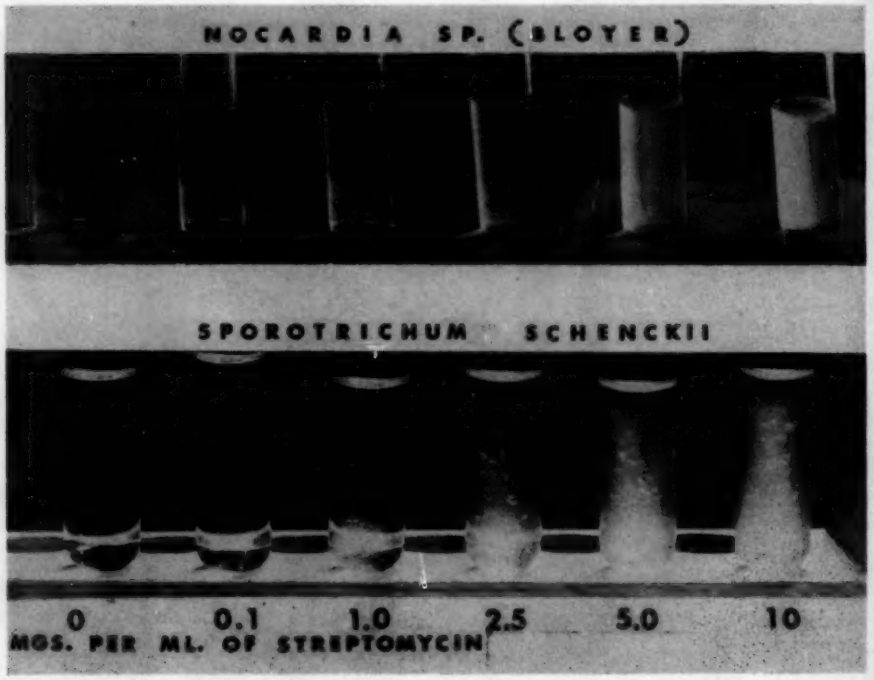


FIG. 1. Enhancement of growth of fungi with streptomycin.

at pH 4.1 (series 3) inhibition was noted, but at pH 5.9 best growth was obtained with the antibiotic at the highest level used. In certain cases, particularly in experiments 1 and 2 with *Candida* and *Cryptococcus*, inhibition was evident at the seventh and twelfth days, but was overcome at later observation periods.

With *T. mentagrophytes*, inhibition was noted in the organic medium (series 2), whereas *P. ochraceum* grew better with streptomycin (series 3). When an inorganic medium was used no effect of streptomycin on the growth of either species was observed.

Discussion. Streptomycin-sensitive, -tolerant and -dependent species and strains have frequently been reported among bacteria. Bacterial strains which utilize other antibiotics as nutrilites have not been reported nearly as often as those requiring streptomycin. This was one of the motivating factors that led to the discovery of neomycin by Waksman and Lechevalier (1949).

It is not so generally appreciated that certain pathogenic fungi may exhibit similar degrees of response to streptomycin, or that sensitivity changes may develop during subculturing of the species. Boand and Novak (1949), however, reported that after ten transfers of *Actinomyces bovis* (6 strains) in a thioglycollate medium, resistance to streptomycin had increased 250 times. Although streptomycin dependence did not develop, 5 of the 6 strains maintained their resistance after 54 transfers in media without streptomycin. One strain, however, reverted to its original sensitivity. Some reports (table 3) indicate that fungi are very resistant to the antibiotic. Robinson, Smith and Graessle (1944), Robinson (1946) and Serri (1948) reported that streptomycin had no effect on *Sporotrichum epigaeum* and *Trichophyton rosaceum*. Segrétain and Drouhet (1948) found that concentrations up to 5000 units per ml. had no effect on *C. neoformans* in a peptone medium. On the other hand, a variant of *Torula utilis* was very sensitive, according to Loo, Carter, Kehm and Anderlik (1950).

The other extreme of response to streptomycin is represented by reports

TABLE 3. *Comparative effect of streptomycin on growth of fungi*

Species	*Investigators*						
	RS	*RO*	*SA*	*RH*	*CS*	*LBW*	
Candida albicans		i 8.0				1–10,	i 6.0 P a 5.9 S
Coccidioides immitis		i 8.0		a .3	a .01–5	1–10,	a 5.9 S
Cryptococcus neoformans	i 4.0	i 4.0				.1–10,	i 6.0 P a 5.9 S
Histoplasma capsulatum			n 2.5		a .01–5	.1–10,	n 6.0 P n 5.9 S
Phialophora verrucosa					a .01–5	.1–10,	a 6.0 P n 4.1 S
Sporotrichum schenckii	i 4.0	i 4.0			a .01–5	.1–10,	n 6.0 P n 4.0 P i 4.1 S a 5.9 S a 6.0 S a 4.0 S
Trichophyton mentagrophytes		i 4.0			a .01–5	2.5, .1–10,	i 6.0 P n 5.9 S

i = inhibition
a = acceleration
n = no effect
P = peptone medium
S = salt medium
RO = Robinson (1946)
RS = Robinson, et al. (1944)
SA = Seabury and Artis (1946)
RH = Roessler, et al. (1946)
CS = Campbell and Saslaw (1949)
LBW = Loefer, Bieberdorf and Weichlein(present paper)
1st series of numbers in each column = mgs./ml. streptomycin
2nd series of numbers in last column = pH

such as those of Roessler, Herbst, McCullough, Mills and Brewer (1946) and Campbell and Saslaw (1949), which point out that some fungi actually utilize this antibiotic as a nutrilite. Their findings are summarized in table 3 in order to compare them with the results we obtained in this series of experiments. In many cases we observed different responses within the same species, and these were often at variance with those reported by others. In some cases where we found no effect with peptone media compared with acceleration in salt media, it could have been due to the fact that abundant growth resulting from utilization of peptone was sufficient to overshadow or mask any accelerative effect that the streptomycin might have had. Yet in some cases better growth was noted even in peptone media. The salt medium, normally supporting only scant or moderate growth was better suited to demonstrate enhancement, and at pH 6.0 it was usually quite possible to detect inhibition as well.

We were unable to demonstrate any correlation between the type of effect noted and the temperature of incubation (i.e., 28° vs. 31° C). Series 5 was also duplicated at pH levels of 4.0 and 6.0 and it was observed that growth was generally better for most species at 6.0. In this connection it is interesting to note that Stokes, Foster and Woodward (1943) found that pH altered the pyridoxine requirement of *Neurospora,* which grew at 6.2–7.3 without it, but not at pH 4.9–5.4. Doede (1945) observed that 4 strains of *Shigella paradysenteriae* Sonne in Gladstone's medium (15 amino acids, salts and glucose) required nicotinic acid at pH 7.0 or 8.0, but not at 6.0.

Time of incubation may have been a factor favoring the development of mutants which utilized streptomycin, since the incubation period extended, in some cases, up to 27 days.

Experiments are being carried out to determine whether fungi may adapt or mutate so as to utilize other antibiotics as nutrilites. The occurrence or possible development of pathogens which utilize antibiotics as nutrilites can have serious clinical implications. Welch, Price and Randall (1946) demonstrated that streptomycin injections increased the fatality rate of mice infected with *E. typhosa.* Foley and Farber (1948) noted that certain strains of *Cryptococcus* in infants likewise appeared to utilize streptomycin.

Aside from the direct utilization of antibiotics, their use may have a serious indirect effect. Woods, Manning and Patterson (1951) believed that suppression of bacterial flora by treatment with antibiotics may actually promote moniliasis (by *Candida albicans*). It is accomplished by destruction of a considerable portion of the bacterial flora, which for the most part is far more sensitive to the antibiotics than the fungi, allowing the latter to overgrow by utilizing the excessive nutrients which would otherwise be consumed by the bacteria. The same phenomenon has also been observed in certain patients at the Santa Rosa Hospital.

A biphasic response to streptomycin and penicillin has been reported by Benham (1947) for *E. typhosa*. This phenomenon, in which inhibition in high and stimulation in low concentrations occurs, has been observed for sulfonamides, narcotics and other substances (Miller, Green and Kitchen 1945) and appears to differ from the type of responses noted in our experiments.

SUMMARY

1. Seventeen strains of fungi were cultured with different concentrations of streptomycin covering the range: 0.0, 0.1, 1.0, 2.5, 5.0 and 10 mgs. per ml. Two types of media were used, one with peptone and one without, and growth was observed in the pH ranges of 4.0–4.1 and 5.9–6.0.

2. Either inhibition or enhancement with streptomycin was obtained with 8 of the 17 fungi tested. The peculiar effects obtained appear to vary with the type of medium used, but seem not to be due to differences in pH and incubation temperatures. When acceleration occurred it was usually best with 5.0 and 10 mgs. per ml. of streptomycin and inhibition was generally also in direct proportion to the concentration.

3. *Nocardia* grown with 2.5–10 mgs./ml. of streptomycin lost its normal orange color.

SOUTHWEST FOUNDATION FOR RESEARCH AND EDUCATION
SAN ANTONIO, TEXAS

Literature Cited

Benham, R. S. 1947. The effect of streptomycin on the oxygen uptake of *Eberthella typhosa*. Science **105**: 69.

Bieberdorf, F. W., & Argabrite, J. W. 1949. Extracts of molds grown on synthetic media. Jour. Allergy **20**: 50–55.

Boand, A., & Novak, M. 1949. Sensitivity changes of *Actinomyces bovis* to penicillin and streptomycin. Jour. Bact. **57**: 501–8.

Campbell, C. C., & Saslaw, S. 1949. Enhancement of growth of certain fungi by streptomycin. Proc. Soc. Exp. Biol. Med. **70**: 562–563.

Campbell, C. C., & Saslaw, S. 1951. Failure of streptomycin to enhance the infectivity of *Histoplasma capsulatum* in mice. Pub. Health Rep. **66**: 16–19.

Carvalho, S. de. 1949. Actions organotropiques. I. Action de la streptomycine sur les cultures de tissus. Note preliminaire. (Organic actions of antibiotics. I. Effect of streptomycin on tissue cultures. Prelim. note). (cf. Biol. Abs. **24**, No. 30,253).

Curran, H. R., & Evans, F. R. 1947. Stimulation of sporogenic and nonsporogenic bacteria by traces of penicillin and streptomycin. Proc. Soc. Exp. Biol. and Med. **64**: 231–233.

Doede, D. R. 1945. The influence of pH upon the growth factor requirements of bacteria. Yale Jour. Biol. and Med. **17**: 595–609.

Foley, G. E., & Farber, S. 1948. Observations on the biology of *Cryptococcus neoformans*: correlation with the pathological changes observed in three cases of cryptococcosis in infants. Proc. Soc. Am. Bact. Ann. Meet., 66.

Hobby, G. L., & Dougherty, N. 1948. Isolation of a streptomycin-resistant organism

capable of utilizing streptomycin for growth. Proc. Soc. Exp. Biol. and Med. **69**: 544–548.

Loefer, J. B. 1949. Penicillin and streptomycin sensitivity of some protozoa. Tex. Jour. Sci. **1**: 92–94.

Loefer, J. B., Bieberdorf, F. W. & Weichlein, R. G. 1950. Effect of streptomycin on growth of certain fungi. Tex. Rep. Biol. and Med. **8**: 105.

Loo, Y. H., Carter, H. E., Kehm, N. & Anderlik, B. 1950. The effect of streptomycin on a variant of *Torula utilis*. Arch. Biochem. **26**: 144–150.

Miller, C. P., & Bohnhoff, M. 1947. Development of streptomycin-resistant variants of *Meningococcus*. Science **105**: 620–621.

Miller, W. S., Green, C. A., & Kitchen, H. 1945. Biphasic action of penicillin and other sulphonamide similarity. Nature **155**: 210–211.

Morgan, H. J., Hunt, J. S., Kent, L. R., & Carlisle, J. M. 1947. Streptomycin. Merck and Co., New Jersey, Special Bull.

Paine, T. F., & Finland, M. 1948. Streptomycin-sensitive, -dependent, and -resistant bacteria. Science **107**: 143–144.

Rake, G. 1948. Streptomycin as an essential nutrilite. Proc. Soc. Exp. Biol. and Med. **67**: 249–253.

Robinson, H. J. 1946. Streptomycin and streptothricin: The absorption, excretion, and chemotherapeutic properties. Ann. N. Y. Acad. Sci. **48**: 119–142.

Robinson, H. J., Smith, D. G., & Graessle, O. E. 1944. Chemotherapeutic properties of streptomycin. Proc. Soc. Exp. Biol. and Med. **57**: 226–231.

Roessler, W. G., Herbst, D. J., McCullough, W. G., Mills, R. C., & Brewer, C. R. 1946. Studies with *Coccidioides immitis*. II. *In vitro* effects of streptothricin and streptomycin. Jour. Infect. Dis. **79**: 23–26.

Seabury, J. H., & Artis, D. 1946. *In vitro* susceptibility of *Histoplasma capsulatum* to therapeutic agents. Proc. Soc. Exp. Biol. and Med. **61**: 15–16.

Segrétain, Gabriel, & Drouhet, E. 1948. L'action de la streptomycine sur *Torulopsis histolytica* (= *Torulopsis neoformans*) *in vitro* and *in vivo*. Compt. Rend. Soc. Bio. **142**: 319–320.

Serri, F. 1948. *In vitro* effect of some antibiotics—penicillin, streptomycin, tyrothricin, furacin—on the development of dermatomycetes. Farmaco **3**: 535–541. (cf. Abs. Wor. Med. **5**: 1837).

Spendlove, G. A., Cummings, M. M., Fackler, W. B., Jr., and Michael, M., Jr. 1948. Enhancement of growth of a strain of *M. tuberculosis* (var. *hominis*) by streptomycin. Publ. Health Repts. **63**: 1177–1179.

Stokes, J. L., Foster, J. W., & Woodward, C. R., Jr. 1943. Synthesis of pyridoxin by a "pyridoxinless" X-ray mutant of *Neurospora sitophila*. Arch. Biochem. **2**: 235–245.

Waksman, S. A., & Lechevalier, H. A. 1949. Neomycin, a new antibiotic active against streptomycin-resistant bacteria, including tuberculosis organisms. Science **109**: 305–307.

Welch, H., Price, C. W., & Randall, W. A. 1946. Increase in fatality rate of *E. typhosa* for white mice by streptomycin. Jour. Am. Pharm. Assn., Sci. Ed. **35**: 155–158.

Woods, J. W., Manning, I. H., Jr., & Patterson, C. N. 1951. Monilial infections complicating the therapeutic use of antibiotics. Jour. Am. Med. Assn. **145**: 207–211.

BULLETIN OF THE TORREY BOTANICAL CLUB
VOL. 79, NO. 3, PP. 251–259 MAY, 1952

STUDIES ON THE LICHEN RINODINA OREINA IN NORTH AMERICA

MASON E. HALE, JR.[1]

Rinodina oreina (Ach.) Mass. is one of the commonest crustose lichens on exposed acid rocks, easily identified by its rosette-shaped yellow thallus. The species has had a rather complicated nomenclatorial history. Acharius (Synop. Lich. 181. 1814) originally described it as *Lecanora oreina* on the basis of various morphological characters. Nylander (1872) divided it into two species according to the color reaction of the thallus with KOH: *Lecanora oreina* Ach. (KOH –) and *L. mougeotioides* Nyl. (KOH + yellow). Vainio (1898), however, studied the type plant of Acharius and found that it reacted KOH +. Therefore he described a new species, *Rinodina hueana* Vain. (KOH –), and reduced Nylander's *mougeotioides* to a synonym of *R. oreina*, which then included all KOH + plants. The transfer of *R. oreina* from Acharius' broad genus *Lecanora* was already effected by Massalongo (Ricerch. Auton. Lich. 16. 1852). This separation of the species by chemistry was further examined and upheld by Hue (1909).

The color reaction of the thallus with P (= paraphenylene-diamine) affords an even more conclusive test for differentiating between *Rinodina hueana* and *R. oreina*. Lynge (1937) was the first to point out that all KOH + specimens turn brilliant orange-red when treated with P, while those reacting KOH – do not change color. For this reason he accepted the two species and cited the distribution of *R. hueana* as Ellesmere to Spitsbergen and Norway and of *R. oreina* as central Europe, a more restricted species.

This separation has been opposed by several lichenologists including Degelius (1943), who found mostly KOH + plants from Swedish Lapland. Magnusson (1944) studied material from Europe and North America and noted greater variation in the chemical reactions than had been previously thought. A large number of North American plants proved to be C (= $Ca(ClO)_2$) + red, whereas the majority of European specimens were C – and P +. He concluded that the chemical variations have no systematic importance in view of the lack of a definite geographical distribution for any of them. He did, on the other hand, retain under var. *hueana* (Vain.)

[1] For the generous loan of herbarium material the writer is indebted to Mr. W. L. Culberson, Drs. C. W. Dodge, F. Drouet, R. C. Friesner, F. Grover, G. N. Jones, J. H. Jones, I. M. Lamb, G. R. Ownbey, J. R. Reeder, J. R. Stevenson, W. L. White, and G. S. Winterringer. Suggestions and criticisms offered by Drs. F. E. Egler, I. M. Lamb, and J. W. Thomson have improved this paper considerably.

H. Magn. those arctic specimens which were P – C – and I (= iodine) + blue in the cortex.

Fink (1935) did not recognize *Rinodina hueana* but included all specimens under *R. oreina*, a practice which has been generally followed in North America.

The conflicting taxonomic treatment of *Rinodina oreina senso lato* convinced the writer that a critical study of this species group in North America would be desirable. The problem involved three studies: 1. the nature of the chemical reactions with P and C and the distribution of the acids in the specimens; 2. a comparative study of some morphological structures; and 3. the geographical distribution of the chemical variations.

Nature of the chemical reactions. The KOH test, as intimated above, is not very satisfactory in the yellow Rinodinae, since even KOH – thalli may give a deceptive color change due to usnic acid in great abundance. The equivalent P test reacts to give an orange-red color in KOH + plants. Microchemical tests indicated the acid causing this reaction is a depsidone in the β-orcin derivative subgroup which is C – (Asahina 1934). The formation of an orange-red compound with P and a yellow condensation product with aniline or ortho-toluidine strongly suggests the presence of protocetraric or fumarprotocetraric acid, but neither of these acids could be positively demonstrated by microchemical methods because of technical difficulties in analysing the crustose material.

The C + red reaction is a characteristic test for certain depsides in the orcin derivative subgroup. By microchemical tests this was easily proved to be gyrophoric acid, a widely distributed lichen substance. It is P –.

A third lichen acid which is probably present in all yellow Rinodinae reacts negatively with P and C. It is indistinguishable from common usnic acid, a lichen substance which lends a yellow color to many lichens.

If I (iodine) is applied to the medulla of *Rinodina oreina*, a blue coloration is observed, especially in the lowest layers. Arctic specimens react on the surface of the thallus and strongly in the medulla as a rule. This I + reaction is usually attributed to the presence of isolichenin in the fungal hyphae. The reagent I, as Magnusson concluded, is of little value if used alone. Since isolichenin is produced in apparently all individuals of *R. oreina*, it seems very doubtful that this reaction has any taxonomic significance at all, even when used in combination with P and C.

Zopf (1907) reported usnic acid and zeorine in European *R. oreina*, which was probably P + C –. The present writer was unable to demonstrate the latter lichen substance in comparable North American material.

Of the total number of individual herbarium specimens examined (300), 53 gave a positive P test. The lichen acid is distributed in the medulla but chiefly in the gonidial and cortical layers. This simple test seems equally

distinctive in all P + plants; certainly variable amounts of the acid must have been present.

The C test was positive in 155 specimens. Furthermore C + gyrophoric acid was never found in conjunction with the P + acid. Although three specimens were provisionally called P + C +, a careful examination showed that this was due to the testing of an admixture of the two chemical types on the same piece of rock. Testing of the same lobe resulted in every case with P + C − or P − C + combinations. Gyrophoric acid is distributed throughout the thallus in most specimens, but it is not so concentrated in the cortex that the application of C on the surface will give a clear red color. Thus it is essential to section a lobe and test the medulla directly. In addition the C test is not especially sensitive, since the final color varies from blood red to pink, disclosing the range of acid concentration in the lichen thallus. In a very few cases the test was inconclusive.

A third group of 92 plants did not give any color reaction with P or C and may be presumed to lack the acids in question. Usnic acid however could be demonstrated in this and the two preceding groups. It will be useful in the following discussions to refer to each of the three chemically dissimilar groups as *strains*, a term often employed in mycology to designate two fungi which differ only in their cultural, physiological, or other non-morphological characters. The results of the chemical studies are summarized for convenience in table 1.

TABLE 1. *Distribution of lichen acids in the three chemical strains of Rinodina oreina*

Chemical reaction	Acids present in the thallus	Number of plants
P+C−	protocetraric (?), usnic	53
P−C+	gyrophoric, usnic	155
P−C−	usnic	92

Morphological structures. Size of the lobes, maximum diameter of the apothecia, average height of the hymenium and size of the asci, and spore dimensions were chosen for a comparative study. There was no intention of undertaking an exhaustive study of the morphology of *R. oreina*. Those interested in such are referred to Hue's monographical treatment of the group (Hue 1909). Rather these few easily measurable structures were selected in order to discover if there are significant variations which might be correlated with the strains. The results are presented in table 2.

Marginal lobation of the thallus is a diagnostic feature of *R. oreina*. The lobes of all strains show a normal variation of size. Arctic and western North American material with P − C − or P − C + reactions tend to be whitish to a bright yellow; P + C − and P − C + plants from the deciduous

TABLE 2. *Measurements of several morphological structures in the chemical strains of Rinodina oreina.*

Reaction		P+C−	P−C+	P−C−	
Number specimens		15	23	12	
Lobes	*range*	.5–1.5×1–3	.5–1×1–3	.5–1.5×1.5–3	.5–1.5×1–3
mm.	*avg.*	.8×2	.8×2.2	.9×2.2	.8×2.1
Apothecia	*range*	.4–1.2	.5–1	.4–1.1	.4–1.2
Max. mm.	*avg.*	.7	.7	.8	.7
Hymenium	*range*	60–80	65–80	60–80	60–80
μ.	*avg.*	70	70.5	71	70.5
Asci	*range*	40–45×13–18	35–48×14–18	35–45×13–18	35–48×13–18
μ.	*avg.*	42.5×14.5	41.5×15	40.5×15.5	41.5×15
Spores	*range*	8–17×4–7.5	8.5–14×4–7	8.5–14×5–8	8–17×4–8
μ.	*avg.*	11×6	11×6.5	11×6.5	11×6.3

forests may be quite identical if growing in full sunshine but are often greenish because of incrustation by green algae. All groups may be more or less areolate in the central portion of the thallus with rounded or angular areolae.

The most conservative structure is the apothecium, as can be judged from table 2. Specimens from the entire range of each strain vary remarkably little. Some arctic and Rocky Mountain material has partially immersed to sessile apopthecia; other specimens have more uniformly adnate to sessile. Bouly de Lesdain (1932) observed that the *Rinodina hueana* (KOH −) collected in New Mexico had such small apothecia that it could be determined as f. *microcarpa* Hue (". . . apotheciis non ultra 5 mill. latis."). Hue measured up to 1.5 mm. for European *R. hueana*. The measurements in table 2 do make the apothecia of North American material on the average slightly smaller than European. The hymenium is uncolored, the epithecium brown with some granular inclusions; KOH quickly dissolves out the color and separates the paraphyses. The size of the paraphyses (1.5–3 μ wide, septate, with an inflated tip 2–5 μ wide) is in good agreement with Hue. Eight spores from each plant or in total 400 spores were measured without finding any significant variation in size between the strains. Mature plants were usually fertile, though one arctic collection had no spores.

Geographical distribution. The distribution of *Rinodina oreina* in North America is still incompletely known, for the 300 specimens examined were collected at only 161 separate localities (fig. 1). Duplication of collections was the most common for example in the prairie region. The species is apparently lacking in the arcto-Pacific sector, including northwest continental North America. There are certainly not enough records to state accurately its northern limit. It is absent too from the entire area lying below the 32° N parallel. In the southwestern states, moreover, it is easily confused with closely related *R. suboreina* and its chemical variant *R. novomexicana*, both described by Bouly de Lesdain. They range from Mexico northward into

FIG. 1. Distribution of *Rinodina oreina* in North America. A dot stands for a P−C+ collection; a triangle for P−C−; and X for P+C−. (Goode Base Map #102. Copyright by The University of Chicago. Used by permission of the University of Chicago Press.)

Arizona, New Mexico, Texas and Colorado. The exact relationship of this group to *R. oreina* is uncertain and in need of a critical study.

The chemical strains seem to fall into several rather definite patterns. The temperate deciduous forest regions, including the Appalachians and certain parts of the Driftless Area in Wisconsin, are unique in having only P + C – and P – C + plants apparently growing intermixed throughout the range. In a field study in Wisconsin the writer collected 95 specimens on two quartzite talus slopes. All of these gave a positive P or C test and occurred in a remarkably constant ratio of 5 P + C – to 8 P – C + plants regardless of amount of shade or any other ecological factors. Both types grew in direct contact 25 per cent of the time.

A similar ratio probably can be found below the limit of glaciation in the Appalachians, while north of this line, as in Connecticut with 22 P – C + and only 2 P + C – herbarium collections, the situation becomes more complex. The writer tested approximately 500 plants in field studies in northwest Connecticut. All were P + C – or P – C + in a ratio varying from 1:7 to 1:10. In a few instances either strain was found in pure isolated colonies. Any of these ratios could imply genetic control of the lichen acids in *R. oreina,* but the means of reproduction and physiology of acid production in this species still remain to be established. If these data do have any significance, they should provide a different approach to the question of the life cycle of lichens.

In the prairies of North America another combination of strains can be discovered, namely P – C + and P – C –, which also grow intermixed. It was not possible to make any extensive field investigations of this group. In southern Wisconsin at least it occurs only on acid rocks in prairies or oak woods.

Collections in the rest of North America are far too scanty for generalizations. Nearly pure populations of P – C – plants occur in California and the Arctic. The isolated P + C – plants in Alberta, Nevada, and Washington cannot be discussed without considerably more field data. Obvious convergence of all strains in an ecotone is apparent only in Minnesota and Wisconsin.

In summary one can infer from the present data that P + C – and P – C – strains do not grow together, the former being most abundant in the deciduous forests, the latter in the prairies and the Arctic where it has invaded large areas following deglaciation. P – C + plants can occur with either of the other strains. All of these chemical strains are part of a complex population which displays great variability in North America.

Discussion. *Rinodina hueana* (P –) was originally distinguished from *R. oreina* (P +) by the KOH or P color test without regard to any other acids which might have been present in the thallus. It should be obvious

from this study that in North American material the C test for gyrophoric acid has equal significance and by its use a third strain can be discovered, the P – C – strain. From this evidence the writer sees no logical basis for the creation of species in the *R. oreina* group simply by the P test which identifies one strain and leaves in the residue the P – C + and P – C – strains. Indeed even a combination of chemical tests does not offer any indication that distinct species exist. For although P + C – and P – C – plants appear to be geographically distinct, the P – C + strain is often ubiquitous with them. Further doubt is cast on the specificity of the chemical strains by the lack of significant morphological variation which correlates with them.

With these facts about *Rinodina oreina* one may ask what will be a reasonable disposition of the chemical strains. Lichenology has not yet developed any tested or generally acceptable concepts for dealing with the urgent problem of "chemical species." Some lichenologists do not attribute any specific importance to the lichen acids, merely ignoring or at best mentioning such characters.

Another school of thought is that proposed by Asahina (1937), who has elevated many chemically different lichens to specific rank. This method has been criticised by many lichenologists, although it is not entirely foreign to the usual procedure of dealing with similar lower plant groups where the segregation of physiological strains is necessary in classifying organisms parasitic on plants and animals of economic importance. Asahina has advanced the hypothesis that the algae in two lichens which are morphologically similar but chemically different are probably not identical. Since that time, some evidence has accumulated that the lichen fungus, at least in the higher lichens as *Cladonia*, produces acids and other metabolic products autonomously (cf. Castle and Kubsch 1949). If this be true, then the lichenized fungi may exist sometimes as physiological races or strains, quite identical with the strains of ordinary fungi. This hypothesis touches on the very nature of lichens which is not the subject of this paper.

A third line of attack has recently been proposed by I. M. Lamb, who has gradually minimized the systematic importance of lichen acids after much field work with lichen populations. In one paper (Lamb 1948) the concept of active and acid-free (or inactive) phases is introduced for the genus *Neuropogon*. The active phase embraces species of *Neuropogon* which contain KOH + or P + acids of the salazic or protocetraric acid groups. Species which do not contain the acids in question are combined in the acid-free phase. The observed distribution of lichen acids in *Rinodina oreina* corresponds well with that in *Neuropogon*. In later papers (Lamb 1951a and b) the above concepts are expanded and illustrated in the genera *Cladonia* and *Stereocaulon*. The individual chemical variations, where there

is a definite replacement of lichen acids, are now assigned the rank of Chemical strains (Ch. str.) with the acid present being indicated in brackets. These concepts are also embodied in a proposal which was offered by Lamb to the International Botanical Congress in 1950.

It is this latter concept which appeals to the present writer as a logical solution for dealing with the chemical strains of *Rinodina oreina,* although it is a new and untested approach. One advantage in its application is that microspecies characterized only by chemical differences are still recognized but now united under one species name which covers a group of morphologically similar plants. Another advantage lies in the fact that as new lichen acids are discovered, as in the *Cladonia chlorophaea* group, a chemical strain can be easily and accurately described without recourse to the usual taxonomic categories which in a strict sense are not suitable for expressing chemical differences. This approach is to be sure only a taxonomic aid and should not imply that our knowledge of lichen acids is increased thereby.

Accordingly the following treatment of *Rinodina oreina s. l.* is proposed. Plants reacting P + C – are referred to *R. oreina* Chemical strain I (typical strain), and those P – C + to *R. oreina* Chemical strain II (gyrophoric acid strain). These belong to the active phase. *R. oreina* P – C – is the inactive phase, presumably of Chemical strain II in view of the distributional data, though future research may alter this status. *R. hueana* then is a synonym of the active and inactive phases of Chemical strain II because it was made in ignorance of the presence of gyrophoric acid in some P – individuals.

SUMMARY

1. Specimens of *Rinodina oreina s. l.* in North America may be divided into three groups or strains by the use of P and C; P + C –, P – C +, and P – C –. The lichen acids responsible for the color tests are protocetraric (?) P + and gyrophoric C +.

2. There is no significant variation in morphology among the strains.

3. The geographical distribution of each strain was determined by examining a large number of herbarium specimens in addition to field studies. P + C – and P – C + strains are typically found in the deciduous forests; P – C + and P – C – strains occur in the prairies and the arctic and some alpine regions.

4. It is proposed that the chemically dissimilar plants be called the Chemical strains of *R. oreina* and not be regarded as different species. Those plants reacting P + C – and P – C + are Chemical strains I and II respectively of the active phase and those P – C – are the inactive phase of II.

DEPARTMENT OF BOTANY, UNIVERSITY OF WISCONSIN
MADISON, WISCONSIN

Literature Cited

Asahina, Y. 1934. Zur Systematik der Flechtenstoffe. Acta Phytochim. **8**: 33–45.

————. 1937. Über den taxonomischen Wert der Flechtenstoffe. Bot. Mag. (Tokyo) **51**: 759–764.

Bouly de Lesdain, M. 1932. Lichens de l'Etat de New Mexico (U. S. A.) recueillis par le Frère G. Arsène Brouard. Ann. Crypt. Exot. **5**: 89–139.

Castle, H., and Kubsch, F. 1949. The production of usnic, didymic, and rhodocladonic acids by the fungal component of the lichen *Cladonia cristatella*. Arch. Biochem. **23**: 158–160.

Degelius, G. 1943. Zur Kenntnis der Flechtenflora um See Virihaure in Lule Lappmark (Schwedisch-Lappland). Bot. Not. **1943**: 75–113.

Fink, B. 1935. The lichen flora of the United States. Ann Arbor.

Hue, A. 1909. Le *Lecanora oreina* Ach. et quelques lichens coréens. Jour. de Bot. **2**: 1–9.

Lamb, I. M. 1948. Further data on the genus *Neuropogon*. Lilloa **14**: 139–168.

————. 1951a. Biochemistry in the taxonomy of lichens. Nature **168**: 38.

————. 1951b. On the morphology, phylogeny, and taxonomy of the lichen genus *Stereocaulon*. Canadian Jour. Bot. **29**: 522–584.

Lynge, B. 1937. Lichens from West Greenland, collected chiefly by Th. M. Fries. Medd. om Grønland **118**: 1–225.

Magnusson, A. H. 1944. Lichens from central Asia. Part II. The Sino-Swedish Expedition. XI. Botany. **22**: 1–71.

Nylander, W. 1872. Addenda nova lichenographiam europaeam. Flora **55**: 353–365.

Vainio, E. A. 1898. Lichenes in Erythraea a doctore K. M. Levander a. 1895 collecti. Hedwigia **37**: 37–39.

Zopf, A. 1907. Die Flechtenstoffe. Jena.

BULLETIN OF THE TORREY BOTANICAL CLUB
VOL. 79, NO. 3, PP. 260–272 MAY, 1952

TORREYA

Additive and Inhibitive Effects Resulting from Treatment of Tomato Seedlings with Indoleacetic Acid in Combination with 2,4-Dichlorophenoxyacetic Acid[1]

A. E. HITCHCOCK

When Bonny Best tomato seedlings 9 to 10 cm. in height were treated with indoleacetic acid (IA) in combination with 2,4-dichlorophenoxyacetic acid (2,4-D) inhibitive or additive effects were obtained, depending upon the dosage level of each compound, the ratio of IA to 2,4-D, and the method of treatment used. The principal method consisted of applying triethanolamine salts of IA and 2,4-D in volumes of 0.001 to 0.01 ml. to the upper surface of leaflets on the fourth leaf by means of a pipette of 0.1 ml. capacity. Several other methods of treatment involving transport of the applied IA and 2,4-D were also used. The range of dosage per plant was 0.1 to 2000 γ IA and 0.01 to 20 γ 2,4-D, except in the case of soil treatments which involved quantities up to 2 mg. per 4-inch pot of soil.

The responses induced by 2,4-D were curvature, elongation, and proliferation of stems, modification of leaves, and changes in the rate of terminal growth. All of these responses except modification were induced by IA, but there were certain qualitative and quantitative differences which served as a guide in evaluating the predominantly inhibitive action of IA, mutual inhibition of IA and 2,4-D, and additive effects, which in some cases were followed by inhibitive effects.

Inhibitive effects resulted from treatment of one leaflet with a mixture of IA and 2,4-D with ratios of IA to 2,4-D ranging from 1: 1 to 1: 1000. The degree of inhibition (2- to 10-fold) depended upon the type and magnitude of the responses induced by a given dose of 2,4-D used alone. Results with mixtures showed that IA functioned as an inhibitor of 2,4-D since the responses were qualitatively and quantitatively the same as those induced by a lower dose of 2,4-D. Since stem curvature (in 2 to 4 days) and proliferation responses induced by 1000 γ IA or less were of a low order of magnitude, it was difficult to determine on the basis of near maximum responses whether 2,4-D had inhibited the action of IA. This type of mutual inhibition occurred with the 0.01 ml. application when the highest dose of IA used in mixtures (1000 γ) induced noticeable proliferation and permanent stem curvature. With the 0.001 ml. application of a mixture containing 1 γ IA and 1 γ 2,4-D initial stem curvature was prevented by the inhibitive action of 2,4-D even though 2,4-D alone induced no curvature within three hours after treatment. This is in contrast to a 20° to 40° curvature induced by 1 γ IA alone. One to three weeks later these plants showed a noticeable inhibitive action of IA on all responses of the 2,4-D-induced type.

In some of the tests the treated leaves were cut off at different time intervals after treatment ranging from 15 minutes to 24 hours. A treatment period of 15 minutes was sufficient for IA to cause stem curvatures of 10° to 20° one hour after the test started, whereas 2,4-D required a treatment period of more than one hour and no curvature occurred before three to five hours after treatment. In contrast, the 15-minute and one-hour treatments with mixtures of IA and 2,4-D induced a greater degree of stem bending and a slower rate and less complete recovery (additive effect) as compared with IA alone. However, the responses on these plants one to three weeks after treatment were noticeably less pronounced than on plants treated only with 2,4-D, showing that the additive effect for initial stem curvature was followed by predominantly inhibitive effects. For example, slight modification in the one-hour treatment and noticeable modification in the five-hour treatment with 2,4-D alone were completely eliminated by the inhibitive action of IA in the mixtures. Both 2,4-D and IA required a treatment period in excess of 24 hours to induce their maximum effects.

[1] Subject of the address of the retiring President of the Torrey Botanical Club presented at the annual meeting on January 15, 1952.

In contrast to the inhibitive effects resulting from treatment of one leaflet with a mixture of IA and 2,4-D, the treatment of the fourth leaf with 2,4-D and the third leaf with IA resulted in additive effects. Treatment of one leaflet with IA and two leaflets on the fourth leaf with 2,4-D resulted in additive effects that were less pronounced than when IA and 2,4-D were applied to different leaves. When only one leaflet was treated with IA and the adjacent (opposite) leaflet with 2,4-D, the effects were inhibitive but not nearly so marked as when a mixture of IA and 2,4-D was applied to a single leaflet. These results indicate that the greater the distance between the sites where 2,4-D and IA were applied, the greater the additive effects and, conversely, the closer the sites of application, the greater the inhibitive effects.

Since IA and 2,4-D are classified as auxins, it is obvious that the terms "auxin-inhibitor" or "anti-auxin" are not applicable to the present results. Results based on *Avena* and pea curvature and straight growth tests are apparently not applicable to tests with intact plants such as the tomato when applied growth regulators such as IA and 2,4-D influence both morphological development and growth. This is further borne out by the fact that additive and inhibitive effects have been obtained with many other growth regulators used in combination with 2,4-D. These include α-naphthaleneacetic, β-naphthoxyacetic, α-(2,4-dichlorophenoxy)propionic, 2,4,5-trichlorophenoxyacetic, and 2,3,5-triiodobenzoic acids (also other substituted benzoic acids), and maleic hydrazide. There are, no doubt, many other compounds which will inhibit the action of 2,4-D, and consequently the structure of the inhibitor appears not to be a specific requirement. If the inhibitive action is a competitive one for important constituents of the cell, such as enzymes or protein compounds, the substrate component would presumably have to belong to a system which controls morphological development as well as growth in order to account for changes in modification of leaves and other organs.

All of the responses induced in tomato by 2,4-D, except modification, have been induced by the stimulus of light and gravity or by capping a part of the plant for several days with light-impervious materials such as black cloth or aluminum foil. The responses induced on tomato by applied growth regulators such as IA and 2,4-D appear to be the same as those induced by substances present in the plant acting under the stimulus of light and gravity, with the exception of modification responses for which no satisfactory explanation has been given as yet.—Boyce Thompson Institute for Plant Research, Inc., Yonkers 3, New York.

Proceedings of the Club

Minutes of the Annual Meeting, January 16, 1951. The meeting, held in the faculty dining-room of Hunter College, was called to order after the annual dinner, at 7:45 P. M. President Clum was in the chair; 105 members and friends were present.

The following were proposed for membership in the Club: Active: Charles Burch, Ithaca, N. Y.; Henry F. Dunbar, Kingston, N. Y.; Estill I. Green, Short Hills, N. J.; Martin B. Harrison, Manhattan, Kans.; Fritz G. Hochwald, New York, N. Y.; Donald G. Huttleston, Brooklyn, N. Y.; Ann Peranio, Patterson, N. J.; Edith L. Smith, Morristown, N. J.; Mathilde P. Weingartner, Staten Island, N. Y.; Agnes White, Richmond Hill, N. Y.; and Warren A. Wistendahl, New Brunswick, N. J.; Associate: Mrs. Albert Blumgart, Newark, N. J.; Margaret T. Hills, New York, N. Y.; Eva Prokopiv, New York, N. Y.; and N. C. Wyckoff, Trenton, N. J. All were elected.

Annual reports were presented by the President, Dr. Clum; by Dr. Simpson as Corresponding Secretary and Chairman of the Program Committee, who announced that dues paid to the Club are, according to a Bureau of Internal Revenue ruling, deductible on Income Tax returns; by the Treasurer, Dr. Lawton, who reported a slight surplus for the year 1950; by Dr. Berger as Editor of the Bulletin; for Miss Schwarten, the Bibliographer; by Mr. Larsen as Business Manager; by Dr. Levine on the Council of the New York Academy of Sciences, who reminded the members that the Academy was no longer including notices of the Club's meetings in their Bulletin; by Dr. Cheney, who represented the Club on the Council of the A.A.A.S.; by Mr. Frazee for the Field

and Local Flora Committees; for Mr. Platt, the Club's representative on the Board of Managers of the New York Botanical Garden; and by Dr. Small for Torreya and for the New York & New Jersey Trail Conference. Dr. Simpson then read the results of the mail ballot as reported by the Nominating Committee. This showed the following as the choice of the membership: for President, A. E. Hitchcock; for Vice-Presidents, M. A. Johnson and L. M. Black; for Corresponding Secretary, Jennie L. S. Simpson; for Recording Secretary, Donald P. Rogers; for Treasurer, Elva Lawton; for Editor, Charles A. Berger; for Business Manager, E. D. Rudolph; for Bibliographer, Lazella Schwarten; for Council, Frederick Kavanagh, Leila V. Barton, E. H. Fulling, and Sam F. Trelease; for Representative on the Board of Managers of the New York Botanical Garden, H. H. Clum; for Delegate to the Council of the N. Y. Academy of Sciences, Michael Levine; for Representatives on the Council of the A.A.A.S., R. H. Cheney and P. W. Zimmerman. No further nominations being offered, a vote was taken for the officers of the Club for 1951, and the above persons were duly elected.

President Hitchcock then assumed the chair and after a word of thanks introduced the retiring president, Dr. Harold Clum of Hunter College, who addressed the Club on the subject "Studying Botany in a Big City". His summary follows:

> Prior to around 1900 there were many native plants within the city limits. A list of the locations of several orchids at that time had been furnished by Mr. Thomas S. Constantine. In contrast the speaker pointed out some of his own difficulties in trying to collect within the city, and mentioned the methods used at Hunter College to teach systematic botany without relying on student collections of plants. The changed conditions in the city have made it harder to interest students in botany. But this lack of interest in botany exists in other parts of the country and professional botanists are trying to combat the trend. The Torrey Botanical Club, through its field trips and meetings, has a great opportunity to help maintain and increase the interest in plants among the citizens of New York.

Dr. Ralph Sargeant of Haverford College then presented a fine series of color photographs of vegetation and individual plants in illustration of his lecture on "The Flora of the Southern Appalachians".

The meeting was adjourned at 10:35.

Minutes of the Meeting of February 6, 1951. The meeting, at Hunter College, was called to order at 8:00 P.M. by President Hitchcock; 53 were present. The minutes of the preceding meeting were read and approved.

Dr. Paul B. Sears, of Yale University, spoke to the Club on "Forest History in Mexico and New Mexico".

The meeting was adjourned at 9:00, and refreshments were then served by the Hunter College botanists.

Minutes of the Meeting of February 21, 1951. The meeting was held at Fordham University, and, after refreshments served by members of the University, was called to order at 4:05 P.M.; sixty-two members and friends were present. The minutes of the preceding meeting were read and approved.

Dr. Charles A. Berger of Fordham addressed the Club on "The Effects of Cortisone on Mitosis".

After discussion the meeting was adjourned at 5:00 P.M.

Minutes of the Meeting of March 6, 1951. The meeting at Hunter College was called to order at 8:00 P.M. by President Hitchcock; thirty-four were present. The minutes of the preceding meeting were read and approved.

Dr. R. R. Stewart of Gordon College, Rawalpindi, Pakistan, gave an illustrated lecture on "Plant Collecting in the Kashmir Himalayas". His summary follows:

> The main Himalayan range divides Kashmir into two distinct regions. The slopes and ranges toward the plains of India are well forested except for the areas which can be cultivated and the alpine pastures above the tree line. The region north of the Himalayas is high, dry, and rugged. There is hardly any rainfall but a great deal of snow falls on the mountains in the winter and the melting snow furnishes water for irrigation where some fields can be made by terracing. The permanent snow line

is about 14,000 feet in the main range and about 18,000 feet in the Tibetan parts of Kashmir. Most of the genera of plants in Kashmir are familiar to North American and European botanists but most of the species are different except for a good many wide-spread weeds and a circumpolar and cold-temperate element in the flora.

After adjournment, at 9:05, refreshments were served by the Hunter College botanists.

Minutes of the Meeting of March 21, 1951. The meeting, at the New York Botanical Garden, was called to order at 8:00 P.M. by President Hitchcock; 29 were present. The minutes of the preceding meeting were read and approved. The report of the Auditors was presented, showing, instead of the anticipated deficit for 1950, a surplus income of about $14.00. It was also noted that the total membership was 732 (of whom 536 were active members), and that the Bulletin was sent to 877 members and subscribers.

Dr. David D. Keck of the New York Botanical Garden presented an illustrated discussion of "Evolutionary Relationships in the Genus Layia". His abstract follows:

> The genus Layia (subtribe Madiinae of the Compositae) contains fourteen species, all of which occur in California, twelve of these being endemic there. For the most part these are amply distinguished by a considerable series of morphological differences, but the prominent morphological differences do not always run parallel to the genetic barriers which separate the natural units. Three different chromosome numbers in the genus indicate the presence of cytological barriers to free interbreeding. Extensive crossing experiments, combined with a thorough study of chromosomal behavior, have furnished data to be used in conjunction with comparative morphological studies for the presentation of a more objective classification of this genus than had been available.

After adjournment, at 9:15, refreshments were served by members of the Garden's staff.

Minutes of the Meeting of April 3, 1951. The meeting was called to order at 8:08 P.M. at Hunter College by President Hitchcock. Thirty-six members and friends were present. The minutes of the preceding meeting were read and approved. Dr. George S. Avery, Jr., of the Brooklyn Botanic Garden, gave an illustrated discussion of "Lapland and the Arctic Flora". An abstract follows:

> Lapland constitutes the northern fourth of the Scandinavian peninsula; the heart of Lapland is the place where Norway, Sweden, and Finland meet; its latitude is about that of central Greenland. During three summer months the valleys and mountainsides are wet from melting snow; for nine months of the year the area is frozen.
>
> In this area there are about two hundred and fifty kinds of plants, mostly perennials. One annual, *Gentiana nivalis*, manages to complete its cycle in the brief growing season. Familiar genera of herbaceous perennials are *Campanula, Geranium, Potentilla, Epilobium, Hieracium, Saxifraga*, goldenrod, and chickweed; the Lapland species are mostly unfamiliar. *Rhododendron lapponicum* (on limestone!), *Andromeda polifolia, Arctostaphylos alpina, Cassiope tetragona*, and blueberries grow as dwarf shrubs.
>
> Trees in Lapland are tree-like only in the lower valleys; at high elevations they are like lawns. There are but five species: *Sorbus aucuparia, Picea abies, Pinus sylvestris, Betula tortuosa*, and a willow.

The meeting was adjourned at 8:50; thereupon the members of the Hunter College botany staff served refreshments.

Minutes of the Meeting of April 17, 1951. The meeting, at Columbia University, was called to order at 8: 00 P.M. by President Hitchcock; thirty-eight persons were present. Dr. Charles R. Dawson of Columbia University spoke on "The Nature of the Toxic Principle of Poison Ivy."

After discussion the meeting was adjourned at 9: 15.

Minutes of the Meeting of May 1, 1951. The meeting was called to order at 8: 05 P.M. by President Hitchcock at Columbia University; sixty-nine people were present. The minutes of the two preceding meetings were read and approved.

Dr. Edward D. DeLameter of the University of Pennsylvania spoke on "Studies on the Nuclear Cytology and Sexuality of Bacteria."

After considerable discussion the meeting was adjourned at 9: 35.

Minutes of the Meeting of May 16, 1951. The meeting, at Hunter College, was called to order at 8: 07 P.M. by President Hitchcock; 45 were present. The minutes of the preceding meeting were read and approved.

The following were elected to membership in the Club: Active Members: C. B. Beck, Cornell University; George L. McNew, Boyce Thompson Institute; Winthrop J. Means, Summit, N. J.; Gerald B. Owenby, University of Minnesota; Richard Snow, North Hollywood, Calif.; Katherine Tryon, University of Michigan; Carol H. Woodward, New York City. Associate Members: Frank E. Horn, Brooklyn, N. Y.; Bruce Reynolds, Jr., New York City; Joseph J. Stegle, Bronxville, N. Y.; Audrey L. Wrede, Brooklyn, N. Y.

The resignation of Mr. Emanuel Rudolph as Business Manager was announced.

Dr. Bassett Maguire of the New York Botanical Garden spoke on "Garden of the Gods," an account of his explorations in Venezuela.

After adjournment, at 9: 15, refreshments were served by the Hunter College botanists.

Minutes of the Meeting of October 2, 1951. The first meeting of the autumn was called to order at Hunter College by President Hitchcock at 8: 16 P.M.; about twenty-five were present. The minutes of the preceding meeting were read and approved.

The following were elected to membership in the Club: Sustaining Member: J. Harry Lehr, Monsey, N. Y.; Active Members: Mrs. Harry F. Blake, Hollis, N. Y.; William P. Cooney, New York, N. Y.; Samuel C. Damon, Philadelphia, Pa.; Samuel Krieger, New York, N. Y.; Jean McMann, Fordham University; Rita McMann, Fordham University; Mahmoud A. Ragab, Iowa City, Iowa; Samuel M. Ringel, New York, N. Y.; F. L. Rosenstiel, Flushing, N. Y.; Joseph E. Schuh, Jersey City, N. J.; and Karlis Starcs, Indianapolis, Ind.; Associate Members: Ralph W. Armstrong, Neptune, N. J.; Harriet J. Brown, Middle Village, N. Y.; Barbara B. Cook, Westfield, N. J.; Melvin E. Fischer, New York, N. Y.; Dean Freiday, Elberon, N. J.; Thelma G. Maginnis, Arlington, N. J.; Marion E. Sonner, Middle Village, N. Y.; and William Wolfman, Long Island City, N. Y.

The resignation of Mr. Frazee as chairman of the Field Committee was announced with regret.

The meeting was then devoted to reports on the summer botanical experiences of the members—mostly field explorations, with an occasional regretful remark by a botanist who had spent the season at a desk.

At 9: 35 the meeting was adjourned for refreshments.

Respectfully submitted,
DONALD P. ROGERS
Recording Secretary

Minutes of the Meeting of October 16, 1951. The meeting was called to order by President Hitchcock at 8: 15 P.M. at Hunter College; twenty-seven members and friends were present.

Miss Carol W. Crane of Summit, N. J., was elected to associate membership.

Dr. Louis G. Nickell of Chas. Pfizer & Co., addressed the Club on "Tissue-culture Studies on Plant Tumors Caused by Virus." His abstract follows:

The tissue with which this talk is chiefly concerned is from the root of *Rumex acetosa* (sorrel). This is the original R_1 isolate made by Dr. L. M. Black in 1945.

Histological examination of tumor tissue grown *in vitro* shows a semi-organized tissue as opposed to the unorganized tissue found in crown gall tissue grown *in vitro*.

Inorganic nutritional studies show an unusually high requirement for phosphate, from 10 to 100 times that required by other plant tissues studied. Normal excised roots of *Rumex acetosa* grown *in vitro* require normal amounts of phosphate and are inhibited

by the levels which are necessary for optimum growth of the virus tumor tissue. Nitrate is the best source of nitrogen. The only other compound, organic or inorganic, which approaches nitrate as the sole source of nitrogen is aspartic acid. Sulfate and sulfhydryl are the best forms of sulfur, while sucrose, glucose and fructose are the best carbohydrate sources. Contrary to results with other plant tissues, the *Rumex* virus tumor tissue very effectively utilizes starch as the sole carbon source. This is due to the secretion of an alpha-amylase by this tissue. This enzyme is not adaptive and its action is unaffected by plant hormones.

Nucleic-acid-derivative studies show that adenine, adenosine, and adenylic acid are inhibitory to growth of this tumor and that uracil, hypoxanthine and xanthine are stimulatory. Dye studies show that four dyes used to stain nucleic acids are stimulatory to growth when added to the medium, vital stains have no effect, and other dyes are inhibitory.

More recently, tissues have been isolated from *Melilotus officinalis* which have good prospects for comparative nutritional studies. So far, virus tumor, crown gall, and normal callus tissue from the stem have been established *in vitro;* also, virus tumor tissue from the root. Because of an unidentified growth requirement which is satisfied by yeast extract, only preliminary nutritional studies have been conducted with these tissues. However, the virus tumor tissues show the high phosphate requirement, whereas the crown gall and callus tissues have normal phosphate requirement.

Much interest was shown in Dr. Nickell's work and considerable discussion followed. Refreshments were served and the meeting adjourned at about 10: 00.

Respectfully submitted,
JENNIE L. S. SIMPSON
Corresponding Secretary

Minutes of the Meeting of November 20, 1951. The meeting, at Hunter College, was called to order at 8: 10 P.M. by President Hitchcock; thirty-five were present. The minutes of the preceding meeting were read and approved.

Mr. Joseph Monachino was elected without dissent to the Council, to replace Dr. Carey.

In fulfillment of a request by the President, the Recording Secretary offered a discussion of "Mushrooms without Complications." He described some of the effects of the ingestion of unwisely selected mushrooms, and gave an account, illustrated by slides, of some of the most surely recognizable edible and poisonous kinds. The President observed that mushrooms still presented complications.

Following adjournment, at 9: 40, refreshments, but no mushrooms, were served by the Hunter College botanists.

Minutes of the Meeting of December 4, 1951. The meeting, at Hunter College was called to order at 8: 00 P.M. by President Hitchcock; thirty-three were present. The minutes of the meetings of October 2 and November 20 were read and approved.

Mr. David Fables was appointed chairman of the Field Committee, and his appointment approved by the Club.

Dr. Giley E. Bard of Hunter College addressed the Club on "Succession on the Piedmont of New Jersey." Her abstract follows:

A study of the patterns of secondary succession on the Piedmont Plateau of New Jersey was begun in the fall of 1948 and involved the investigation of a series of fallow fields in Somerset County. Fields abandoned 1, 2, 5, 10, 15, 25, 40, and 60 years previously were examined ecologically, their soils analyzed, and their root-profiles compared with conditions obtaining in Mettler's Woods, a mature oak-hickory forest near East Millstone, which may be considered as a presumed end-point to succession on the Piedmont.

Fields abandoned for one year contain the subsequent herbaceous dominants in insignificant amounts, but the immediate dominants are *Ambrosia artemisiifolia* and *Oenothera parviflora.* By the second year of abandonment, *Solidago nemoralis* assumes and retains dominance for approximately fifteen years when *S. juncea* supersedes it and

becomes the dominant herb of sixty-year old fields. *Aster ericoides* increases its dominancy by the fifth year and may maintain high coverage for approximately twenty more years. *Andropogon scoparius* attains dominancy by the fifteenth year and remains an important herb for more than forty-five years. *Juniperus virginiana* invades young fields within the first few years of abandonment and becomes the dominant arborescent species for over sixty years. Most of the arborescent species of the oak-hickory forest enter the succession before the red cedar is mature and are often in the understory by the sixtieth year of abandonment. The two shrubs of the succession exhibiting greatest coverage are *Rubus flagellaris* and *Rhus radicans*.

As the succession progresses, the number of annuals and non-indigenous species decreases, and the number of species whose fruits or seeds are dispersed either epizoically or endozoically increases. There appears to be a lack of decisive correlation between any of the investigated physical and chemical properties of the soil and the age of abandonment of the fields. Moreover, there is no evidence in the comparative root-systems of the earlier and later arborescent dominants to indicate their differential competitive ability. It would appear that the oaks and hickories do not entirely delay entrance until a preparatory bed of cedar is established, but that once the climax species have undergone invasion, the seedlings of the cedar eventually succumb, whether for want of light, water, or some other factor or factors. The older cedars gradually deteriorate, and the stand increasingly attains the composition and maturity of an oak-hickory forest.

The meeting was adjourned for refreshments at 8: 55.

Minutes of the Meeting of December 18, 1951. The meeting, at Columbia University, was called to order at 8: 05 by President Hitchcock; twenty-five were present.

It was proposed to amend the Constitution of the Club so that two articles read as follows: ARTICLE XII—Members. The membership of the club shall consist of active (including sustaining and life) and associate members. Associate members may attend all meetings and field trips of the Club, but shall not be eligible to vote or hold office. Each Associate Member shall receive the notices of the field trips and other announcements of the club. Each Active Member shall receive all current publications of the Club except the Index Cards, Memoirs, and other special publications of the club. Payment at one time of a sum designated by the Council shall entitle a member to become a Life Member without further payment of dues. After payment of annual dues for forty years, an Active Member shall be eligible to election to Life membership and, in special cases, others may likewise be elected to Life membership. ARTICLE XIII—Dues. The dues of all classes of membership shall be fixed by the Council. This proposal was referred to the Council.

The proposed budget for 1952, already adopted by the Council, was presented. In it are presented an estimated income of $8112.00 and the following expenditures: BULLETIN, $6000; advertising, $200; TORREYA reprints, $250; Editor's office, $60; index cards, $700; Bibliographer, $150; Treasurer's office, $100; Business Manager, $175; Corresponding Secretary's office, $15; Field Committee, $200; Committee for increasing membership and subscribers, $50; general expenses, $75; Total, $8100. It was voted without dissent that the budget be approved.

The minutes of the preceding meeting were then read and approved.

The following were elected to membership: active members, Arthur T. McManus, Astoria, N. Y.; T. C. Joseph, Fordham University; Lamar C. Brown, Sacaton, Arizona; Isabel Carter, Point Pleasant, N. J.; LeRoy G. Kavaljian, Brooklyn Botanic Garden; associate member, Aage Bohus Jensen, Philadelphia, Pa.

Dr. Donald D. Ritchie of Barnard College then addressed the Club on "Mitochondrial Alterations in Undifferentiated Cells of *Allomyces* under Experimental Conditions." His abstract follows:

The undifferentiated vegetative hyphae of aquatic fungi are useful in the study of cytoplasmic particles because such hyphae can be subjected to experimental treatment while controls, maintained in a known environment, can be easily kept for comparison. With phase contrast optics, mitochondria of *Allomyces* can be seen when normal, as small spheres, short rods, or long filaments, seeming blue-black in color, and capable of independent movement. They can be photographed without fixing or staining, although sharper negatives can be obtained if the fast and constant movement of the mitochondria is stopped by 0.5% osmium tetroxide, which causes no visible alteration.

Work on specialized mammalian tissues has indicated that mitochrondria may be isolated intact in isotonic saline or in certain specific concentrations of sucrose. Mitochondria of *Allomyces* could not be isolated in either medium. If hyphae are mounted in isotonic saline (for *A. javanicus*, 1.3–1.4%), the mitochondria are so sensitive to mechanical disturbance that if pressure is applied to a cover glass, they disintegrate. Hypertonic saline causes a general plasmolysis followed by slow recovery, but the mitochondria swell to large, spherical vesicles which become vacuolate and vague, and then disappear. Flooding of a hypha with 0.88M. sucrose causes severe immediate plasmolysis, accompanied by dispersal of the mitochondrial bodies.

Cooling down to 8° C. had no effect, but heating to about 50° caused a change in refractivity of the mitochondria. Further heating caused no further change until a temperature of nearly 80° was reached, at which point they broke up into apparently hollow beads which then disappeared. No independent movement of mitochondria was recorded above 65°, but hyphae held at 69° for 10 minutes had apparently normal mitochondria capable of movement when returned to 35°.

Earlier work has shown that with proper concentration of KCN, up to about 90% of the oxygen uptake of *Allomyces* can be inhibited. Many recent studies have been designed to show that mitochondria (liver, kidney) are centers of respiration; and mitochondria have been described as damaged by cyanide in cells of higher plants. In *Allomyces*, the only visible effects of KCN are that movement is stopped, and the ability of the mitochondria to accumulate Janus green is destroyed.

Triphenyl tetrazolium chloride, which can be reduced to a red insoluble product (formazan), was used to indicate the sites of oxidations in the cells. At any concentration above 0.01%, the tetrazolium salt was so toxic that it destroyed all organization in the cytoplasm. At 0.005%, granules in the cytoplasm showed strongly red after 48 hours, particularly when hyphae were kept under a cover glass, since a lowered oxygen supply characteristically results in a stronger reaction. The colored granules were all spherical, and were most striking in or near the tips of the hyphae. Since none of the elongated, writhing mitochondria could be found in the tetazolium-treated plants, it is not at this time possible to know whether the "stained" granules are or are not the same as what we have been referring to as mitochondria. In high concentrations of the salt, all the cytoplasm becomes red, especially in the younger parts of the thallus.

In view of the different ways in which the particles called mitochondria behave under experimental treatments in different organisms, it appears possible or even likely that all the inclusions referred to by that term are not necessarily the same or comparable bodies.

The meeting was adjourned at 9: 15.

Minutes of the Annual Meeting of January 15, 1952. After dinner at the Men's Faculty Club of Columbia University the meeting was called to order at 7: 55 by President Hitchcock. Sixty-three members and friends were present. The minutes of the preceding meeting were read and approved.

By vote of the Club the following persons were elected to membership: Active Members, Hugh N. Mozingo, Florida Southern College; Alice E. Petersen, New Rochelle, N. Y.; Associate Member, Mrs. Frank Parker, Philadelphia, Pa.

Reports were made by Dr. Hitchcock, President, and Dr. Simpson, Corresponding Secretary. As chairman of the Publications Exchange Committee Dr. Simpson reported that seven periodicals are received in exchange by and at Columbia University, five at the New York Botanical Garden for Columbia, and nineteen by the Garden. The Treasurer, Dr. Lawton, reported that the membership at the end of 1951 numbered 32 Life, 3 Sustaining, 521 Annual, and 172 Associate Members (a loss of 4 from 1950); that there were 334 paid subscribers to the BULLETIN (an increase of 28); that the Endowment Fund amounted to $36,147.58 (an increase of about $2300, mostly from the Britton Estate); and that the income assignable to general funds amounted to $8167.78 (an increase of around $800), and expenditures to $8124.64. Father Berger, the Editor, reported the publication of 498 pages in the last volume of the BULLETIN at a cost of $6458.50. Dr. Jakowska read the report of Mr. Rudolph, Business Manager until September, and of her own work in the office for the rest of the year.

Dr. Levine, the Club's representative on the Council of the New York Academy of Sciences, reported that the Academy had altered its constitution so as (purportedly) to

deny the affiliated societies (of which the Torrey Botanical Club is one) a full voice in the Council. In reply to a question he further reported that the Academy's other agreements with the Club—to publish notices of the Club's meetings and to recognize the associate membership in the Academy of the Club's members—had been broken by the Academy. Dr. Cheney, as a representative of the Club on the Council of the American Association for the Advancement of Science, outlined the new objectives of the Association—synthesis of the Sciences, and activity in public relations, rather than the sponsoring and management of meetings of scientists. Dr. Zimmerman, the Club's second representative, described the physical difficulties of the last A.A.A.S. convention and other details of that meeting. Dr. Clum reported as representative on the Board of Managers of the New York Botanical Garden; Dr. Simpson read Dr. Small's communication as Delegate to the New York and New Jersey Trail Conference, and the President read Dr. Small's report as Editor of TORREYA. Dr. Rickett described the present status of Dr. Stout's paper on *Petunia* reproduction being readied for the MEMOIRS.

The Recording Secretary reported that the Council had approved the proposed amendments to the Constitution. It then developed that under Art. 20 the matter could not be acted on until the next meeting. The Corresponding Secretary reported that by the mail vote the following had been chosen for office in the Club for 1952: for President, M. A. Johnson; 1st Vice-president, Murray Buell; 2nd Vice-president, L. M. Black; Corresponding Secretary, Jennie L. S. Simpson; Recording Secretary, Donald P. Rogers; Treasurer, Elva Lawton; Editor, Charles A. Berger; Business Manager, Sophie Jakowska; Bibliographer, Lazella Schwarten; Representative, Board of Managers of the New York Botanical Garden, Harold H. Clum; Delegate, Council N. Y. Academy of Sciences, Michael Levine; Representatives, Council of the A.A.A.S., R. H. Cheney and P. W. Zimmerman; Members of the Council, Annette Hervey, David Keck, Dorothy Meier, Lindsay S. Olive. It was voted without dissent that the nominations be closed and the Secretary directed to cast one vote for each of these nominees. The vote having been cast, they were declared elected.

President Johnson then assumed the chair and introduced the speaker of the evening, Dr. A. E. Hitchcock of the Boyce Thompson Institute for Plant Research, who addressed the Club on "Additive and Inhibitive Effects Resulting from Treatment of Tomato Seedlings with Indoleacetic Acid in Combination with 2,4-Dichlorophenoxyacetic Acid." His address is printed on p. 260.

The meeting was adjourned at 10: 20.

Respectfully submitted,
DONALD P. ROGERS
Recording Secretary

BOOK REVIEWS

Ferns of Georgia. By Rogers McVaugh and Joseph H. Pyron. xviii + 195 pp., including drawings and maps. The University of Georgia Press. 1951. $5.00.

This is truly a worthy addition to the list of "fern books" which have been issued in recent years. By securing the support of over 200 local garden clubs as well as some private individuals the authors have been able to beat the mounting cost of book production, and to offer a substantial volume replete with excellent line drawings and distribution maps. Seventy-eight entities, including the so-called "fern allies," are recognized, each uniformly treated in a page of text facing a page of illustrations by the junior author; this plan makes the book a handy one to use.

Georgia would not be regarded by most travellers as a state likely to exhibit an extensive fern flora, so it comes as no surprise to learn that from 13 counties no ferns have been collected, while from each of 42 counties not more than two species have been recorded. Doubtless these figures indicate lack of field work as well as scarcity of ferns. The authors have travelled 6000 miles in connection with the project. But the dis-

tribution maps clearly indicate that (1) about nine species reach the south limit of their range in the highlands of northern Georgia; (2) four or more species, including several tropical ferns (notably *Dryopteris dentata*) reach the north limit of their range near the Florida boundary; (3) soil reaction obviously accounts for the distribution of many species. Fifteen species are known from only one station, and *Lygodium palmatum* is admitted to the list on the strength of William Bartram's report of finding "filix scandens"; no specimens from Georgia have been found in the large herbaria. *Vittaria lineata* is recorded from Lincoln Co., more than 300 miles north of other stations in Florida.

In spite of the patronage by garden clubs, the only feature related to fern culture is in the statement referring to habitat, including the soil reaction, of each species. And yet the treatment should be regarded as popular in a very desirable sense of the word. A few of the "common names" look unfamiliar to this reviewer; they may of course be local names, though one cannot but recall Fernald's disapproval of "names arbitrarily invented by enthusiasts in such manufacture." It will surely take a long time to convert the amateur to saying "brownstem spleenwort" instead of "ebony spleenwort."

A characteristic feature is the position of all keys in a section following the Introduction to the book, and consisting of the Key to the Genera, followed by the Key to the Species. These keys have been carefully constructed, as a few tests have shown. But the only warning the amateur has that he is dealing with plants which may be sorted out into groups which are only remotely related is in a paragraph on page eight, which divides pteridophytes into four groups, without stating even briefly the features which distinguish these. In the text one passes without a break from the pages on *Dennstaedtia* to those on *Lygodium*, and from *Osmunda* to *Ophioglossum*. The authors' reply to such remarks would probably be that their aim was to enable the field observer to find the probable name of a specimen by means of the keys, then turn to the detailed treatment and illustration in order to confirm the identification, hoping that the observer would be attracted to at least a few of the interesting details which are contained in the paragraphs "name," "habitat," "range." If the observer follows this path, he or she will be well rewarded.—M. A. CHRYSLER, Rutgers University.

A Guide to the Spring Flowers of Minnesota. Eighth Edition. By C. O. Rosendahl and F. K. Butters. 108 pp., Burgess Publishing Company. 1951.

This excellent guide has been used for quite a few years now. It has been both a useful guide to students learning the Minnesota flora and a source of satisfaction to amateur botanists of the state. Its several editions have witnessed successive changes and additions. The sixth edition, for example, which appeared in 1931 was the first which included generic descriptions. The big change in this latest edition is the abandonment of the Besseyan system and a return to that of Engler and Prantle. Some people will greatly regret Dr. Rosendahl's decision to make this change. However, he did it because the user of the guide is dependent upon the more comprehensive treatments for species descriptions and these still adhere to the Engler-Prantle system.

The earlier editions were published by the University of Minnesota Press. The eighth edition, on the other hand, has been published by the Burgess Publishing Company. Although the larger format and the loss of some illustrative detail through the use of offset printing are unfortunate, the book remains of great value to the botanists of Minnesota, both professional and amateur.—MURRAY F. BUELL, Rutgers, the State University of New Jersey.

Pollination in the Faroes—in Spite of Rain and Poverty in Insects. By O. Hagerup. 48 pages; figs. 1–74. Det Kongelige Danske Videnskabernes Selskab. Biologiske Meddelelser, bind 18, nr. 15 (Dan. Biol. Medd. 18, no. 15). Copenhagen. 1951. $1.00.

Species from genera such as *Calluna, Lychnis, Ranunculus, Hypericum,* and *Armeria* which are considered typical entomophiles in Denmark are found in the Faroes. The almost complete absence of bees and butterflies in the Faroes prompted a restudy of the importance of insects in pollination. Flies may be of local importance but their distribution is concentrated around bird-cliffs and other places where cunghills or rotting seaweeds may be found. Even the activity of flies may be reduced by prolonged periods of rain. The most important pollinating insect may be the fly, *Eristalis intricarius* L.

Some 57 genera are discussed in more or less detail and with figures. Pollination by wind, by insects, and pollination of one flower by pollen from another flower on the same plant receive consideration and may be applicable to some species. Self pollination is given most complete discussion and the possibility is raised "that various species have developed particular autogamous races in the Faroes. . . ."

One finds little that appears to be controversial in the study.—JOHN A. SMALL.

Plants of Big Bend National Park. By W. B. McDougall and Omer E. Sperry. xiii + 209 pages; figs. 1–190. Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. $1.00.

This paper covered book is conveniently sized for its purpose—to be taken into the field as "an illustrated book to aid in identifying the various kinds of plants seen." Part of a page is given to "Types of Vegetation in the Park." The types are 1. Desert scrub, 2. Desert grassland, 3. Pinyon-juniper-oak woodland, 4. Ponderosa pine-Douglas fir-Arizona cypress forest. This is the nearest approach to ecology in the book, and the ecological characteristics of these groups are not pointed out. Why is this? In the Introduction we read of the Park: "It is a land of contrasts. Although it consists predominantly of semiarid plains characterized by gravel-covered slopes, arroyos, and washes, this general landscape is interrupted by conspicuous mountain belts and by the winding Rio Grande which has carved spectacular canyons through some of the rugged highlands." Surely visitors would be interested in the ecological principles that must be graphically illustrated here. A book can be just a list of plants in systematic sequence but this is only for convenience of arrangement and identification, whereas in nature plants have ecological requirements as individuals instead of as families. The ecological requirements are as interesting as the name and often more surprising.

After some instruction on plant structure and use of keys, there follows an eight page key to the families of vascular plants of the Park. Pages 15 through 193 take up these families in order with keys and descriptions. Within the families the keys and descriptions are carried to the lesser groups if they be numerous.

If the characteristics on the plant are as distinct as they are stated in the keys, identification should be easy and rapid in most cases. In a few instances, e.g., *Cyperus* and some Cactaceae, differentiation of species is not described. There is a glossary, an index to scientific names, and an index to common names.

Readers may be interested to know that similar books dealing with Glacier National Park ($1.00), Mount Rainier National Park ($1.00), Rocky Mountain National Park (55¢), and Yellowstone National Park (50¢) are available. A complete checklist of about 100 National Park Service Publications is available upon request. Mr. H. Raymond Gregg, Acting Chief Naturalist, advises us of the following: "Flowers of the Southwest Deserts" by Natt N. Dodge, 1951, 112 pp., illus. Southwestern Monuments Associations, Santa Fe, N. M. $1.00. "Flowers of the Southwest Mesas" by Pauline M. Patraw, 1951, 112 pp., illus. Same publisher. $1.00. "Trees and Forests of Glacier National Park" by Donald M. Robinson, 1950, 48 pp., illus. Glacier Natural History Association, Inc., West Glacier, Mont. 50¢. "Check List of Plants, Sequoia and Kings Canyon National Parks" by Sylvia Stagner, 1951, 48 pp., mimeographed. The Sequoia Natural History Association, Three Rivers, California. Dr. McDougall has also completed a manuscript on the plants of the Natchez Trace Parkway which is awaiting for some group to offer a sponsorship.—JOHN A. SMALL.

UNIVERSITY OF MICHIGAN LIBRARIES

Notes

Mr. Ardeshir P. Tata, Hon. Secretary of the Bombay Hikers, who may be addressed at Kamla Nivas, 2, Proctor Road, Grant Road, Bombay 7, has sent us a few of the leaflets distributed to their members during 1951. Each sheet announces one to three hikes and the sheets appear to be issued once or twice a month. The announcement takes the form of a printed letter to members and also includes Club Notes. Hiking is a good deal the same around the world it seems. Mr. Tata pleads for dues, drops defaulters, sells "New Yorker" pork-pie hiking hats, and arranges the monsoon—"Jupiter Pluvius took a day off during the course of the three weeks continuous downpour this year and that day happened to be a hiking Sunday. The residents of Khandalla were confined to their homes by heavy rains from Wednesday to Saturday. We coming up for the Bhor Ghat hike to Khandalla on Sunday morning found ideal weather for an ideal hike. Here's hoping that Messrs. J. P. & Co., of Mount Olympus will keep a kindly eye on us in the years to come."

The Bombay Hikers would like to exchange programs, field schedules, or gossip with other hiking groups. It would surely be worth the postage—J. A. S.

The Torrey Botanical Club will participate with the Northeastern Section of the Botanical Society of America in its annual summer foray. The group will assemble at the University of Maryland on Monday p.m., June 16. Several points of interest in the Beltsville area will be visited Tuesday. Stops will be made Wednesday en route to Richmond where dormitory facilities will be available. The next two days at least will be devoted to places of interest, particularly those where Fernald collected in extending the representation of Virginia's flora in the Manual. Mr. Jason R. Swallen, Head Curator, Department of Botany, Smithsonian Institution, Washington 25, is chairman.

Another meeting of interest to botanists is that of the American Institute of Biological Sciences which will be held at Cornell University, Ithaca, N. Y., September 8 to 10. Many of the botanical societies will be holding their annual meetings at the same time and place with papers, symposia, and other sessions of general interest. There will be opportunity to visit the famous Cornell Plantations and other points of interest in the vicinity.—J. A. S.

Floral Eponyms

Blighia (Bligh, William. 1754–1817.) consists of three tropical African trees of the family Sapindaceae, one of which is cultivated in Southern Florida for its edible fruit.

William Bligh accompanied Captain Cook on his second expedition as sailing master of the "Resolution." He was nicknamed "Breadfruit Bligh" because of the discovery of that fruit on the voyage. In 1787 he was sent in H.M.S. "Bounty" to fetch breadfruit for introduction to the West Indies. A mutiny broke out and Bligh and 18 others were set adrift in the Pacific Ocean. After a voyage of 4000 miles in an open boat, Bligh and his companions reached Batavia in safety. What became of the mutineers has been told by Lord Byron in "The Island" and this nautical incident has become a part of the world's literary lore.

Bligh fought at Copenhagen (1801). From 1805 to 1808 he was Governor of New South Wales, where his soldiers mutinied and kept him a prisoner until 1810. When he died in London in 1817 he held the rank of admiral.—M. Pierce Rucker, M.D.

Bougainvillaea (Bougainville, Louis Antoine de. 1729–1814.) is the handsomest of all tropical vines. It is very popular in Southern U. S. and California. The 10 known species belong to the family Nyctaginaceae.

De Bougainville was a celebrated Franch navigator who added much to our knowledge of the South Pacific. He is known chiefly for his voyage around the world and the account which he published of that voyage. Of interest to North Americans is the fact that he was with Montcalm in Canada in 1756 and with Count De Grasse at Yorktown.—M. Pierce Rucker, M.D.

Gaylussacia (Gay-Lussac, Joseph Louis. 1778–1850.), better known as huckleberry or whortleberry, a fruitbearing species of the heath family, is a valuable ground cover in shaded, peaty places. *G. brachycera* or juniper berry has small blue fruit. It is frequently confused with the blueberry, a species of Vaccinium.

Gay-Lussac, the distinguished French chemist and physicist, was born at St. Leonard, in the department of Haute Vienne. He was successively professor of chemistry at the Ecole Polytechnique, professor of physics at the Sorbonne, and professor of chemistry at the Jardin des Plantes. In 1806 he was made an academician and in 1831 he was elected to represent Haute Vienne in the chamber of deputies. He was particularly interested in the chemistry and physics of gases and formulated the law of combination by volumes. In 1804 he made several balloon ascensions to study gases at high altitudes.—M. PIERCE RUCKER, M.D., and Virginia Medical Monthly.

Rafflesia (Raffles, Sir Thomas Stamford. 1781–1826.) is a small genus of Malaysian stemless, leafless plants. The huge flowers grow parasitically on the stems of various species of cissus. The flower of *R. Arnoldi* (Arnold, Joseph. 1782–1818.) is the largest known and often attains a diameter of 3 feet and a weight of 15 lbs.

Sir Thomas Stamford Raffles was born at sea off Jamaica. He is spoken of by Singer as the greatest colonial administrator. He was Lieutenant-Governor of Java and secured Singapore for the British. He recognized the strategic importance of the tip of the Malay Peninsula. The *Nepenthes Rafflesiana* (pitcher plant), which he discovered at Singapore, is also named for him. He was an authority on Malayan language, history and customs. He founded the Zoological Society and was its first president. His greatest claim to fame was that he secured for Great Britain the maritime supremacy of the eastern seas.

Joseph Arnold, M.D. was born at Beccles and graduated in medicine at Edinburgh (1807). He was a surgeon in the British navy and accompanied Sir Stamford Raffles on his journeys through Sumatra. He died in Sumatra of fever contracted on his explorations.—M. PIERCE RUCKER, M.D., and Virginia Medical Monthly.

UNIVERSITY OF MICHIGAN PERIODICS

BULLETIN OF THE TORREY BOTANICAL CLUB

VOL. 79, NO. 3, pp. 273–283 MAY, 1952

INDEX TO AMERICAN BOTANICAL LITERATURE

COMPILED BY

LAZELLA SCHWARTEN

WITH THE COLLABORATION OF THE EDITORS OF THE TAXONOMIC INDEX

TAXONOMY, PHYLOGENY AND FLORISTICS

ALGAE

(See also under Plant Physiology: **Arnow *et al*; Sargent & Lantrip; Williams.**)

Cave, Marion S. & Pocock, Mary Agard. Karyological studies in the Volvocaceae. Am. Jour. Bot. **38**: 800–810. 10 D 1951.

Irénée-Marie, *Frère*. Desmidiées de la région de Québec. Nat. Canad. **78**: 177–211. Jl–Au; 301–339. O 1951. **79**: 11–45. Ja 1952.

Taylor, Wm. Randolph. The algal genus *Chrysophaeum*. Bull. Torrey Club **79**: 79. Ja-F 1952.

Thompson, R. H. *Schizodictyon*, a new genus in the Palmellaceae. Am. Jour. Bot. **38**: 780–783. 10 D 1951.

BRYOPHYTES

Jennings, Otto Emery. A manual of the mosses of western Pennsylvania and adjacent regions. *2nd ed.* 1–396. *illust.* Univ. Notre Dame Press. Notre Dame, Ind. 1951.

Koch, Leo Francis. Bryophytes of Chetco River Redwood State Park, Oregon. Madroño **11**: 209–214. Ja 1952.

FUNGI

(See also under Morphology: **Raper & Fennell.**)

Benjamin, R. K. & Shanor, Leland. Sex of host specificity and position specificity of certain species of *Laboulbenia* [3 sp. nov.] on *Bembidion picipes*. Am. Jour. Bot. **39**: 125–131. F 1952.

Carmichael, J. W. The pulmonary fungus *Haplosporangium parvum*. II. Strain and generic relationships. Mycologia **43**: 605–624. N-D 1951 [Ja 1952].

Cooke, W. Bridge. Some Myxomycetes from south central Washington. Northw. Sci. **25**: 171–175. N 1951 [Ja 1952].

Culberson, William L. Some lichens from eastern Kentucky. Lloydia **14**: 181–186. S [D] 1951.

Dennis, R. W. G. Murrill's West Indian species of *Marasmius*. Kew Bull. **1951**: 196–210. 1951.

Dennis, R. W. G. Some Agaricaceae of Trinidad and Venezuela. Leucosporae: Part I. Brit. Mycol. Soc. Trans. **34**: 411–482. *pl. 19–23*. 28 S 1951.

Dennis, R. W. G. Species of *Marasmius* described by Berkeley from tropical America. Kew Bull. **1951**: 153–163. 1951.

Groves, J. Walton. A *Dermea* [*pruni*] on *Prunus* from China. Mycologia **43**: 719–722. N-D 1951 [Ja 1952].

Hacskaylo, Edward. A study of the roots of *Pinus virginiana* in relation to certain Hymenomycetes suspected of being mycorrhizal. Jour. Wash. Acad. **41**: 399, 400. 26 D 1951.

UNIVERSITY OF MICHIGAN HERBARIA

Hughes, S. J. *Annellophora* nom. nov. (≡ *Chaetotrichum* Syd. non Rabenh.). [Includes U. S. records.] Brit. Mycol. Soc. Trans. **34**: 544–550. 28 S 1951.

Hughes, S. J. *Stachylidium, Gonytrichum, Mesobotrys, Chaetopsis* and *Chaetopsella*. [Includes U. S. spp.] Brit. Mycol. Soc. Trans. **34**: 551–576. 28 S 1951.

Johnson, T. W., Ziegler, A. W. & Linthicum, Betty. A note on *Dictyuchus pseudodictyon*. Mycologia **43**: 728, 729. N-D 1951 [Ja 1952].

Karling, John S. Polycentric strains of *Phlyctorhiza variabilis*. Am. Jour. Bot. **38**: 772–777. 10 D 1951.

Koch, William J. Studies in the genus *Chytridium*, with observations on a sexually reproducing species. Jour. Elisha Mitchell Soc. **67**: 267–278. *pl. 19–21*. D 1951.

Korf, Richard P. A monograph of the Arachnopezizeae. Lloydia **14**: 129–180. S [D] 1951.

Lamb, L. M. On the morphology, phylogeny and taxonomy of the lichen genus *Stereocaulon*. Canad. Jour. Bot. **29**: 522–584. O 1951.

Mains, E. B. Entomogenous species of *Hirsutella, Tilachlidium* and *Synnematium*. Mycologia **43**: 691–718. N-D 1951 [Ja 1952].

Miller, Julian H. Studies in the Phyllachoraceae I. *Phyllachora ambrosiae* (Berk. and Curt.) Sacc. Am. Jour. Bot. **38**: 830–834. 10 D 1951.

Murrill, William A. Florida Gasteromycetes. Lloydia **14**: 187–193. S [D] 1951.

Murrill, William A. Florida rosy-spored Agaries. Lloydia **14**: 194–200. S [D] 1951.

Olive, Lindsay S. Taxonomic notes on Louisiana fungi. III. Additions to the Tremellales. Mycologia **43**: 677–690. N-D 1951 [Ja 1952].

Payette, Albert. La lépiote brune [*Lepiota brunnea*] à Sainte-Anne-de-la-Pocatière et dans la voisinage. Ann. ACFAS **17**: 165. N 1951.

Raper, Kenneth B. & Fennell, Dorothy I. Two noteworthy fungi from Liberian soil. Am. Jour. Bot. **39**: 79–86. 10 Ja 1952.

Richards, Merfyn. The life-history of *Diplophlyctis laevis*. [Occurs in U. S.] Brit. Mycol. Soc. Trans. **34**: 483–488. *pl. 23*. 28 S 1951.

Suter, Loyal S. A new species of *Nocardia, N. fastidiosa*, n. sp., isolated from a penile ulcer. Mycologia **43**: 658–676. N-D 1951 [Ja 1952].

Tinline, R. D. Studies on the perfect stage of *Helminthosporium sativum*. Canad. Jour. Bot. **29**: 467–478. *pl. 1, 2*. O 1951.

Weber, George F. *Corticium microsclerotia* nom. nov. Mycologia **43**: 727, 728. N-D 1951 [Ja 1952].

White, W. Lawrence, & Downing, Mary H. *Coccospora agricola* Goddard, its specific status, relationships, and cellulolytic activity. Mycologia **43**: 645–657. N-D 1951 [Ja 1952].

PTERIDOPHYTES

(See also under Spermatophytes: **Lepage.**)

Bartholomew, Elizabeth Ann. The genus *Botrychium* in West Virginia. Castanea **16**: 135–137. D 1951.

Correll, D. S. *Dryopteris setigera* in Texas. Am. Fern Jour. **41**: 124. O-D 1951.

Degener, Otto & Hawkes, Alex D. The holly fern. Am. Fern Jour. **14**: 117–120. O-D 1951.

Diddell, Mary W. Is *Thelypteris reducta* Small a valid species? Am. Fern Jour. **41**: 107–110. O-D 1951.

Manton, I. Problems in cytology and evolution in the Pteridophyta. *i–xi*, 1–316. *illust.* Cambridge Univ. Press. Cambridge. 1950.

Reed, Clyde F. Notes on the ferns of Kentucky, II. *Trichomanes boschianum.* Am. Fern Jour. **41**: 120–123. O-D 1951.

Rugg, Harold G. The climbing fern in Vermont. Am. Fern Jour. **41**: 116, 117. O-D 1951.

Stokey, Alma G. Duration of viability of spores of the Osmundaceae. Am. Fern Jour. **41**: 111–115. O-D 1951.

Tindale, Mary D. Notes on three Australasian ferns. Am. Fern Jour. **41**: 97–106. O-D 1951.

SPERMATOPHYTES

Ahles, Harry E. *Erigeron provancheri* in New York State. Bull. Torrey Club **79**: 88, 89. Ja-F 1952.

Alamo de Bosque, María Felicia del. Begonias. Revista Soc. Cub. Bot. **8**: 16, 17. Ja-S 1951.

Allard, H. A. *Carex pauciflora* in West Virginia. Castanea **16**: 145. D 1951.

Allard, H. A. White-flowered form of bluebells (*Mertensia virginica*) [*f. alba*]. Castanea **16**: 112. S 1951.

Allen, Caroline K. & Gregory, Luis E. A new species of *Licaria* from Puerto Rico. Brittonia **7**: 267–269. 10 D 1951.

Alston, A. H. G. & Schultes, Richard Evans. Studies of early specimens and reports of *Ilex vomitoria.* Rhodora **53**: 273–279. D 1951 [2 Ja 1952].

Anderson, Edgar. Hybridization of the habitat. Evolution **2**: 1–9. Mr [20 Ap] 1948.

Artz, Lena. *Xerophyllum asphodeloides* (L.) Nutt. in the Massanutten Mountains in Virginia. Castanea **16**: 124, 125. D 1951.

Babcock, Ernest B. Supplementary notes on *Crepis* II. Phylogeny, distribution and Matthew's principle. Evolution **3**: 374–376. D 1949 [10 Ja 1950].

Bartlett, H. H. Regression of × *Quercus Deamii* toward *Quercus macrocarpa* and *Quercus Muhlenbergii.* Rhodora **53**: 249–264. *pl. 1176–1180.* 21 N 1951.

Blakelock, R. A. A synopsis of the genus *Euonymus* L. Kew Bull. **1951**: 210–290. 1951.

Bravo Hollis, Helia. Nuevas especies del género *Epithelantha.* Anal. Inst. Biol. [Mexico] **22**: 15–23. D 1951.

Britton, Donald M. Cytogenetic studies in the Boraginaceae. Brittonia **7**: 233–266. 10 D 1951.

Cayouette, Richard. Trois additions à la flore adventice du Québec. Ann. ACFAS **17**: 155, 156. N 1951.

Clausen, Jens. Evolution in *Crepis.* Evolutionary patterns in the genus *Crepis.* Evolution **3**: 185–188. 15 Je 1949.

Constance, Lincoln. *Howellanthus,* a new subgenus of *Phacelia.* Madroño **11**: 198–203. Ja 1952.

Dutilly, *Père* **Arthème & Lepage,** *Abbé* **Ernest.** Exploration sommaire de la rivière Harricana [Quebec]. Nat. Canad. **78**: 253–283. 9 S 1951.

Eaton, R. J. A new color form of *Polygala pauciflora.* Persistence of color forms of *Polygala pauciflora.* Rhodora **54**: 27, 28. Ja 1952.

Erskine, D. S. Species newly or rarely reported from Nova Scotia and Cape Breton Island. Rhodora **53**: 264–271. 21 N 1951.

Graves, Arthur Harmount. Illustrated guide to trees and shrubs. 1–240. *illust.* The Author. Wallingford, Connecticut. 1952.

Harris, Stuart K. & Bean, Ralph C. *Wolffia columbiana* in Methuen, Massachusetts. Rhodora **53**: 272. 21 N 1951.

Harrison, S. G. *Pinus caribaea* (slash pine). Kew Bull. **1951**: 297–300. 1951.

Hawkes, Alex D. Notes on a collection of orchids from Ponape, Caroline Islands. Pacif. Sci. **6**: 3–12. Ja 1952.

Herbert, P. E. New plant records for St. Joseph County, Indiana. Am. Midl. Nat. **46**: 767–777. N 1951 [Ja 1952].

Hodgdon, A. R. *Glyceria septentrionalis* and *G. acutiflora* in Lee, New Hampshire. Rhodora **54**: 25–27. Ja 1952.

Johnston, Ivan M. Studies in the Boraginaceae XXII. Noteworthy species, chiefly Asian and South American. Jour. Arnold Arb. **33**: 62–78. 15 Ja 1952.

Kobuski, Clarence E. Studies in the Theaceae, XXV. The genus *Anneslea*. Jour. Arnold Arb. **33**: 79–90. 15 Ja 1952.

Ledin, R. Bruce. The Compositae of south Florida. Quart. Jour. Fla. Acad. **14**: 51–207. Je-S [29 N] 1951.

Lepage, Ernest. Entités nouvelles dans la flore du Québec. Nat. Canad. **78**: 341–352. O 1951.

Lepage, Ernest. New or noteworthy plants in the flora of Alaska. Am. Midl. Nat. **46**: 754–759. N 1951 [Ja 1952].

Lepage, *Abbé* Ernest. Notes sur l'aire de distribution de quelques plantes du Québec. Ann. ACFAS **17**: 156–159. N 1951.

Li, Hui-Lin. The genus *Tovara* (Polygonaceae). Rhodora **54**: 19–25. Ja 1952.

Li, Hui-Lin. A taxonomic review of the genus *Actinidia*. Jour. Arnold Arb. **33**: 1–61. 15 Ja 1952.

Loock, E. E. M. The pines of Mexico and British Honduras. Union So. Africa Dept. Forestry Bull. **35**: 1–244. [1950].

McMillan, Calvin. The third locality for *Cupressus Abramsiana* Wolf. Madroño **11**: 189–194. Ja 1952.

McVaugh, Rogers. A revision of the North American black cherries (*Prunus serotina* Ehrh., and relatives). Brittonia **7**: 279–315. 10 D 1951.

Maguire, Bassett. The genus *Acioa* in America. Brittonia **7**: 271–273. 10 D 1951.

Martínez, Maximino. Las Casimiroas de México y Centroamérica. Anal. Inst. Biol. [Mexico] **22**: 25–140. D 1951.

Mason, Herbert L. A new *Bacopa* [*Nobsiana*] from California. Madroño **11**: 206–208. Ja 1952.

Masson, Pierre. Un élément subarctique dans les Laurentides: le *Ranunculus lapponicus* L. Ann. ACFAS **17**: 164, 165. N 1951.

Meikle, R. D. & Baldwin, J. T. Eriocaulaceae and Xyridaceae in Liberia. Am. Jour. Bot. **39**: 44–51. Ja 1952.

Meyer, Frederick G. *Valeriana* in North America and the West Indies (Valerianaceae). Ann. Mo. Bot. Gard. **38**: 377–503. N 1951 [31 D].

Moore, H. E. Critical studies. Article 5. Some American Coryphæ. 6. Various new palms. 7. *Neonicholsonia* vs. *Woodsonia*. 8. *Clinosperma*. 9. New names in *Anthericum*. 10. Notes on New World *Gerania*. 11. *Petronymphe*, a new genus of Amaryllidaceæ. Gent. Herb. **8**: 209–260. *illust.* 30 N 1951.

Muñiz Cartaya, José R. Distribución geográfica de las *Cattleya*. Revista Soc. Cub. Bot. **8**: 6–15. Je-S 1951.

UNIVERSITY OF MICHIGAN LIBRARIES

Ponce de León y Aymé, Antonio. La denominación científica de la yamagua. Revista Soc. Cub. Bot. **8**: 3–5. Ja-S 1951.

Raymond, Marcel. La distribution de l'*Eriophorum brachyantherum* Trautv. & Meyer et de l'*Eriophorum callitrix*. Cham. en Amérique du Nord. Nat. Canad. **78**: 285–298. 9 S 1951.

Raymond, Marcel. Le *Carex ormostachya* Wiegand en Amérique du Nord. Ann. ACFAS **17**: 159–162. N 1951.

Raymond, Marcel. Une nouvelle variété de l'*Eriophorum callitrix* Cham. Bull. Soc. Bot. Fr. **98**: 6–8. 1951.

Reed, Clyde F. *Azolla caroliniana* in Maryland. Castanea **16**: 143, 144. D 1951.

Reed, Clyde F. A white form of the seashore mallow, *Kosteletzykya virginica* [*f. alba*]. Castanea **16**: 128. D 1951.

Rollins, Reed C. Sources of genetic variation in *Parthenium argentatum* Gray (Compositae). Evolution **3**: 358–368. D 1949 [10 Ja 1950].

Royen, P. van & Steenis, C. G. G. J. van. *Eriandra*, a new genus of Polygalaceae from New Guinea. Jour. Arnold Arb. **33**: 91–95. *pl. 1*. 15 Ja 1952.

St. John, Harold. Notes on Hawaiian species of *Scaevola* (Goodeniaceae). Hawaiian Plant Studies 19. Pacif. Sci. **6**: 30–34. Ja 1952.

Salamun, Peter J. A population study of the variation in the inflorescence of *Spiraea tomentosa*. Rhodora **53**: 280–292. D 1951 [2 Ja 1952].

Sandwith, N. Y. *Amyris sandemanii* [Peru]. Hook. Ic. V. **5**: *pl. 3496*. D 1950.

Schmoll, Carolina. Una nueva especie de *Epithelantha* [*spinosior*]. Anal. Inst. Biol. [Mexico] **22**: 11–14. D 1951.

Schultes, Richard Evans. Studies in the genus *Hevea* IV. Notes on the range and variability of *Hevea microphylla*. Bot. Mus. Leafl. **15**: 111–138. *pl. 6–40*. 21 Ja 1952.

Sherff, Earl Edward. *Dahlia Moorei*, a new dahlia (fam. Compositae) from northwestern Hidalgo. Bot. Leafl. **5**: 22–24. 22 D 1951.

Sherff, Earl Edward. New entities in the genus *Cheirodendron* Nutt. ex. Seem. (fam. Araliaceae) from the Hawaiian Islands. Bot. Leafl. **5**: 1–14. 22 D 1951.

Sherff, Earl Edward. Some new or otherwise noteworthy members of the genus *Bidens* L. (fam. Compositae) from tropical East Africa. Bot. Leafl. **5**: 14–22. 22 D 1951.

Sherff, Earl Edward. Two Hawaiian species of the genus *Sophora* L. (fam. Leguminosae). Bot. Leafl. **5**: 24, 25. 22 D 1951.

Širjaev, G. New species of Fabaceae. Brittonia **7**: 275–277. 10 D 1951.

Stebbins, G. L. Evolution in *Crepis*. Speciation, evolutionary trends, and distribution patterns in *Crepis*. Evolution **3**: 188–193. 15 Je 1949.

Summerhayes, V. S. *Epidendrum Chondylobolbon* [Mexico]. Bot. Mag. **168**: *pl. 160*. O 1951.

Summerhayes, V. S. *Pleurothallis Tuerckheimii*. Bot. Mag. **168**: *pl. 170*. 19 D 1951.

Williams, Louis O. The Orchidaceae of Mexico. Ceiba **2**: 1–98. 20 Je; 99–194. 15 Au; 195–274. 20 O; 275–321. 31 D 1951.

Woods, Frank. The status of *Ilex collina* Alexander. Castanea **16**: 126, 127. D 1951.

Yokoyama, R. & McGregor, R. L. Variation of *Quercus Muchlenbergii* in Kansas. Trans. Kan. Acad. **54**: 370–373. 1951.

ECOLOGY AND PLANT GEOGRAPHY

Hamel, Aubert. Premier aperçu de la végétation des comtés de l'Islet et Kamouraska [Quebec]. Ann. ACFAS **17**: 162–164. N 1951.

Hetzer, W. A. & McGregor, R. L. An ecological study of the prairie and pasture lands in Douglas and Franklin Counties, Kansas. Trans. Kan. Acad. **54**: 356–369. 1951.

Pittendrigh, Colin S. The bromeliad-*Anopheles*-malaria complex in Trinidad. I. the bromeliad flora. Evolution **2**: 58–89. *pl. 1–4.* Mr [30 Ap] 1948.

Senn, Harold A. A bibliography of Canadian plant geography IX. 1941–1945 nos. 4385–5402. Dept. Agr. Div. Bot. Ottawa Publ. **863**: 1–183. D 1951.

Shreve, Forrest. Vegetation of the Sonoran Desert. Carnegie Inst. Wash. Publ. **591**: 1–192. *illust.* 1951.

PALEOBOTANY

Hoskins, J. H. & Cross, A. T. The structure and classification of four plants from the new Albany shale. Am. Midl. Nat. **46**: 684–716. N 1951 [Ja 1952].

Horn af Rantzien, Henning. On the fossil Charophyta of Latin America. Sv. Bot. Tidsk. **45**: 658–677. 15 D 1951.

Schemel, Mart P. Small spores of the Mystic coal of Iowa. Am. Midl. Nat. **46**: 743–750. N 1951 [Ja 1952].

Stewart, Wilson N. A new *Pachytesta* [*hexangulata*] from the Berryville locality of southeastern Illinois. Am. Midl. Nat. **46**: 717–742. N 1951 [Ja 1952].

Tasch, Paul. A cyclical occurrence of *Cryptozoon undulatum*. Am. Midl. Nat. **46**: 751–753. N 1951 [Ja 1952].

MORPHOLOGY

(including anatomy and cytology in part)
(See also under Algae: **Cave & Pocock**)

Akamine, Ernest K. Germination of seed of koa haole (*Leucaena glauca* L.) (Benth). Pacif. Sci. **6**: 51, 52. Ja 1952.

Boke, Norman H. Leaf and areole development in *Coryphantha*. Am. Jour. Bot. **39**: 134–145. F 1952.

DeLamater, Edward O. Preliminary observations on the occurrence of a typical mitotic process in micrococci. Bull. Torrey Club **79**: 1–5. Ja-F 1952.

Dermen, Haig. Ontogeny of tissues in stem and leaf of cytochimeral apples. Am. Jour. Bot. **38**: 753–760. 10 D 1951.

Eames, Arthur J. Leaf ontogeny and treatments with 2,4-D. Am. Jour. Bot. **38**: 777–780. 10 D 1951.

Einset, John. Apomixis in American polyploid blackberries. Am. Jour. Bot. **38**: 768–772. 10 D 1951.

Guilford, Vivian B. & Fisk, Emma L. Megasporogenesis and seed development in *Mimulus tigrinus* and *Torenia fournieri*. Bull. Torrey Club **79**: 6–24. Ja-F 1952.

Hall, Benedict A. The floral anatomy of the genus *Acer*. Am. Jour. Bot. **38**: 793–799. 10 D 1951.

Heimsch, Charles & Stafford, Helen J. Developmental relationships of the internodes of maize. Bull. Torrey Club **79**: 52–58. Ja-F 1952.

Hooker, W. J. & Sass, J. E. Histological aspects of potato stem necrosis incited by *Streptomyces scabies*. Am. Jour. Bot. **39**: 15–19. 10 Ja 1952.

Hoshaw, Robert W. & Guard, Arthur T. Morphological and anatomical effects of 2,4-D on young corn plants. Bot. Gaz. **113**: 65–74. S 1951 [Ja 1952].

Jensen, H. W. The normal and parthenogenic forms of *Orobanche uniflora* L. in the eastern United States. Cellule **54**: 133–142. 1951.

Macior, Walter A. & Matzke, Edwin B. An experimental analysis of cell-wall curvatures and approximations to minimal tetrakaidecahedra in the leaf parenchyma of *Rhoeo discolor*. Am. Jour. Bot. **38**: 783–793. 10 D 1951.

Mehra, P. N. & Kachroo, P. Sporeling germination studies in Marchantiales. Bryologist **54**: 1–16. Mr [24 Ap] 1951.

Raper, Kenneth B. & Fennell, Dorothy I. Stalk formation in *Dictyostelium*. Bull. Torrey Club **79**: 25–51. Ja-F 1952.

Seigerman, Norman. Three-dimensional cell shape in coconut endosperm. Am. Jour. Bot. **38**: 811–823. 10 D 1951.

Sinnott, Edmund W. Reaction wood and the regulation of tree form. Am. Jour. Bot. **39**: 69–78. 10 Ja 1952.

Sterling, Clarence. Ontogeny of the *Phylloxera* gall of grape leaf. Am. Jour. Bot. **39**: 6–15. 10 Ja 1952.

Sterling, Clarence. Origin of buds in tobacco stem segments cultured in vitro. Am. Jour. Bot. **38**: 761–767. 10 D 1951.

Tiagi, B. Studies in the family Orobanchaceae. II. A contribution to the embryology of *Aeginetia indica* Linn. Bull. Torrey Club **79**: 63–78. Ja-F 1952.

Whaley, W. Gordon, Mericle, Leo W. & Heimsch, Charles. The wall of the meristematic cell. Am. Jour. Bot. **39**: 20–26. 10 Ja 1952.

GENETICS

(including cytogenetics)

(See also Morphology: **Jensen**; under Spermatophytes: **Babcock**; **Britton**; **Clausen**; **Rollins**; **Stebbins**)

Bateman, A. J. & Mather, K. The progress of inbreeding in barley. Heredity **5**: 321–348. D. 1951.

Brown, Walter V. & Coe, Gerald E. A study of sterility in *Hilaria belangeri* (Steud.) Nash and *Hilaria mutica* (Buckl.) Benth. Am. Jour. Bot. **38**: 823–830. 10 D 1951.

Davidson, John F. & Bomberg, Paul F. Genetic variation in *Andropogon*. Madroño **11**: 203–206. Ja 1952.

Fincham, J. R. S. A comparative genetic study of the mating-type chromosomes of two species of *Neurospora*. Jour. Genet. **50**: 221–229. 1951.

Garber, M. J. Approach to genotypic equilibrium with varying percentages of self-fertilization and cross-fertilization (one autosomal gene-pair). Jour. Hered. **42**: 299, 300. N-D 1951 [F 1952].

Hanson, W. D. An interpretation of the observed amount of recombination in interchange heterozygotes of barley. Genetics **37**: 90–100. Ja 1952.

Lewis, D. Structure of the incompatibility gene III. Types of spontaneous and induced mutation [in *Oenothera organensis*]. Heredity **5**: 399–414. D 1951.

Menzel, Margaret Y. & Brown, Meta S. Polygenomic hybrids in *Gossypium*. II. Mosaic formation and somatic reduction. Am. Jour. Bot. **39**: 59–69. 10 Ja 1952.

Mittwoch, Ursula. Studies in the genetics of some X-ray-induced morphological mutants in *Coprinus lagopus*. Jour. Genet. **50**: 202–205. *pl. 3–5*. 1951.

Nielsen, Etlar L. Cytology and breeding behavior of twin plants of *Bromus inermis*. Bot. Gaz. **113**: 23–54. S 1951 [Ja 1952].

Nitsch, J. P., *et al.* The development of sex expression in cucurbit flowers. Am. Jour. Bot. **39**: 32–43. 10 Ja 1952.

Papazian, Haig P. The incompatibility factors and a related gene in *Schizophyllum commune*. Genetics **36**: 441–459. S 1951.

Powers, LeRoy. Gene analysis of the partitioning method when interactions of genes are involved. Bot. Gaz. **113**: 1–23. S 1951 [Ja 1952].

Rollins, Reed C. & Catchside, D. G. A note on some techniques of obtaining genetic segregation in apomictic strains of the guayule rubber plant. Genetics **36**: 435–440. S 1951.

Sager, Ruth. On the mutability of the waxy locus in maize. Genetics **36**: 510–540. S 1951.

Smith, Harold H. Relation between sterility and morphological characters in an interspecific *Nicotiana* cross. Genetics **37**: 26–38. Ja 1952.

Smith, Stanley G. Mutations in polyploid cereals IV. A segmental chromosome deficiency determining an α series ratio in a speltoid wheat. Canad. Jour. Bot. **29**: 607–630. D 1951.

Subramaniam, M. K. Tetraploidy in yeasts. Cellule **54**: 143–148. *pl.* 1951.

Traub, Hamilton P. Colchicine-induced *Hemerocallis* polyploids and their breeding behavior. Plant Life **7**: 83–116. 1951.

Walters, James L. Heteromorphic chromosome pairs in *Paeonia californica*. Am. Jour. Bot. **39**: 145–151. F 1952.

Walters, Marta Sherman. Spontaneous chromosome breakage and atypical chromosome movement in meiosis of the hybrid *Bromus marginatus* × *B. pseudolaevipes*. Genetics **37**: 8–25. Ja 1952.

Wheeler, H. E. & McGahen, J. W. Genetics of *Glomerella* X. Genes affecting sexual reproduction. Am. Jour. Bot. **39**: 110–119. F 1952.

Whitehouse, H. L. K. A survey of heterothallism in the Ustilaginales. Brit. Mycol. Soc. Trans. **34**: 340–355. 28 S 1951.

Wilson, G. B. & Bowen, C. C. Cytological effects of some more antibiotics [on *Allium* root tips]. Jour. Hered. **42**: 251–255. S-O [D] 1951.

Zobel, Bruce. The natural hybrid between Coulter and Jeffrey pines. Evolution **5**: 405–413. 31 D 1951.

PLANT PHYSIOLOGY

(See also under Fungi: **White & Downing**; under Pteridophytes: **Stokey**; under Morphology: **Hooker & Sass**; under Genetics: **Nitsch *et al.***)

Arnow, Peter, *et al.* The effect of triazolo pyrimidine analogs on the growth of *Stichococcus subtilis*. Am. Jour. Bot. **39**: 151–153. F 1952.

Bald, J. G. Stomatal droplets and the penetration of leaves by plant pathogens. Am. Jour. Bot. **39**: 97–99. F 1952.

Cooil, Bruce J. The influence of various sodium and potassium salts upon the growth of young *Avena* seedlings. Plant Physiol. **26**: 822–831. O 1951.

Cutter, V. M., Wilson, Katherine S. & Dubé, J. F. The endogenous oxygen uptake of tissues in the developing fruit of *Cocos nucifera*. Am. Jour. Bot. **39**: 52–56. 10 Ja 1952.

De Ropp, R. S. The growth capacity of the sunflower hypocotyl. Plant Physiol. **26**: 778–783. O 1951.

Ergle, David R. & Eaton, Frank M. Sulphur nutrition of cotton. Plant Physiol. **26**: 639–654. O 1951.

Gerloff, Gerald C., Fitzgerald, George P. & Skoog, Folke. The mineral nutrition of *Microcystis aeruginosa*. Am. Jour. Bot. **39**: 26–32. 10 Ja 1952.

Greulach, Victor A. The effect of maleic hydrazide on tomato plants in relation to their age at the time of treatment. Plant Physiol. **26**: 848–852. O 1951.

Hall, Vernon L. Biochemical composition of cotton leaves and their chemical defoliation as affected by environment. Plant Physiol. **26**: 677–686. O 1951.

Hansch, Corwin, Muir, Robert M. & Metzenberg, Robert L. Further evidence for a chemical reaction between plant growth-regulators and a plant substrate. Plant Physiol. **26**: 812–821. O 1951.

Hivon, Katharine J., Doty, D. M. & Quackenbush, F. W. Ascorbic acid and ascorbic acid oxidizing enzymes of green bean plants deficient in manganese. Plant Physiol. **26**: 832–835. O 1951.

Hsiang, Tsung-Hsun T. Physiological and biochemical changes accompanying pollination in orchid flowers. II. Respiration, catalase activity, and chemical constituents. Plant Physiol. **26**: 708–721. O 1951.

Kramer, Paul J. Causes of injury to plants resulting in flooding of the soil. Plant Physiol. **26**: 722–736. O 1951.

Larsen, Poul. Enzymatic conversion of indole acetaldehyde and naphthalene acetaldehyde to auxins. Plant Physiol. **26**: 697–707. O 1951.

Lee, Addison E. The growth of excised immature sedge embryos in culture. Bull. Torrey Club **79**: 59–62. Ja-F 1952.

McCoy, Thomas A., Bostwick, David G. & Devich, A. Charles. Some effects of phosphorus on the development, the B vitamin content and the organic composition of oats. Plant Physiol. **26**: 784–791. O 1951.

Montgomery, F. H. The effect of boron on the growth and seed production of alsike clover, *Trifolium hybridum* L. Canad. Jour. Bot. **29**: 597–606. D 1951.

Sargent, Marston C. & Lantrip, Lester W. Photosynthesis, growth and translocation in giant kelp. Am. Jour. Bot. **39**: 99–107. F 1952.

Smith, Cyril B. The nutrient-element balance of the tomato and its susceptibility to *Phytophthora infestans* as affected by two levels of zinc. Plant Physiol. **26**: 737–749. O 1951.

Tanrikut, Selahattin & Vaughan, Edward K. Studies on the physiology of *Sclerotinia sclerotiorum*. Phytopathology **41**: 1099–1103. D 1951.

Tatum, Lloyd A. & Curme, John H. Some responses of young corn plants to maleic hydrazide. Plant Physiol. **26**: 836–839. O 1951.

Van Overbeek, J., Blondeau, René & Horne, Vesta. Difference in activity between 2,4-dichlorophenoxyacetic acid and other auxins, and its significance in herbicidal action. Plant Physiol. **26**: 687–696. O 1951.

Williams, Louis G. Effects of indoleacetic acid on growth in *Codium*. Am. Jour. Bot. **39**: 107–109. F 1952.

Wilson, Katherine S. & Cutter, V. M. The distribution of acid phosphatases during development of the fruit of *Cocos nucifera*. Am. Jour. Bot. **39**: 57, 58. 10 Ja 1952.

Wittwer, S. H. & Lundahl, W. S. Autoradiography as an aid in determining the gross absorption and utilization of foliar applied nutrients. Plant Physiol. **26**: 792–797. O 1951.

Wood, R. K. S., Gold, A. H. & Rawlins, T. E. Electron microscopy of primary cell walls treated with pectic enzymes. Am. Jour. Bot. **39**: 132, 133. F 1952.

Yamanouchi, M. & Joslyn, M. A. Investigations of ascorbic acid dehydrogenase of peas (*Pisum sativum*) and its distribution in the developing plant. Plant Physiol. **26**: 757–762. O 1951.

Zscheile, F. P. Nutrient studies with the wheat bunt fungus, *Tilletia caries*. Phytopathology **41**: 1115–1124. D 1951.

PHYTOPATHOLOGY

(See also under Plant Physiology: **Bald**; **Smith.**)

Baldacci, E. & Orsenigo, M. Chestnut blight in Italy. Phytopathology **42**: 38, 39. Ja 1952.

Erwin, Donald C. *Phytophthora* root rot of safflower. Phytopathology **42**: 32–35 Ja 1952.

Foster, R. E. & Foster, A. T. Studies in forest pathology VIII. Decay of western hemlock on the Queen Charlotte Islands, British Columbia. Canad. Jour. Bot. **29**: 479–521. *pl. 1–6.* O 1951.

Goheen, Austin C., *et al.* Witches'-broom on Douglas-fir in Washington. Northw. Sci. **25**: 183, 184. N 1951.

Gopalkrishnan, K. S. Development and parasitism of *Physoderma graminis* (Büs.) Fischer, on *Agropyron repens* (L.) Beauv. Phytopathology **41**: 1065–1076. D 1951.

Gupta, B. M. & Price, W. C. Mechanism of inhibition of plant virus infection by fungal growth products. Phytopathology **42**: 45–51. Ja 1952.

Harvey, John M. Bacterial leaf spot of *Umbellularia californica.* Madroño **11**: 195–198. Ja 1952.

Jackson, L. W. R. Influence of littleleaf on quality of shortleaf pine seed. Phytopathology **42**: 57, 58. Ja 1952.

Kunkel, L. O. Transmission of alfalfa witch's broom to nonleguminous plants by dodder, and cure in periwinkle by heat. Phytopathology **42**: 27–31. Ja 1952.

Leach, J. G. & Elliott, Edward S. The blackpatch disease of red clover and other legumes in West Virginia. Phytopathology **41**: 1041–1049. D 1951.

Littau, Virginia C. & Black, L. M. Spherical inclusions in plant tumors caused by a virus. Am. Jour. Bot. **39**: 87–95. 10 Ja 1952.

Lynch, Donald W. Diameter growth of ponderosa pine in relation to the Spokane pine-blight problem. Northw. Sci. **25**: 157–163. N 1951 [Ja 1952].

Murneek, A. E. Thiolutin as a possible inhibitor of fire blight. Phytopathology **42**: 57. Ja 1952.

Pound, Glenn S. & Stahmann, Mark A. The production of a toxic material by *Alternaria solani* and its relation to the early blight disease of tomato. Phytopathology **41**: 1104–1114. D 1951.

Pound, Glenn S. & Walker, J. C. Mosaic resistance in cabbage. Phytopathology **41**: 1083–1090. D 1951.

Price, W. C. & Fenne, S. B. Tomato rosette, a severe disease caused by a strain of tobacco mosaic virus. Phytopathology **41**: 1091–1098. D 1951.

Steinberg, Robert A. Occurrence of *Bacillus cereus* in Maryland soils with frenched tobacco. Plant Physiol. **26**: 805–811. O 1951.

Stover, R. H. Association in tobacco of the severe symptom response to etch virus and the white burley character. Phytopathology **41**: 1125, 1126. D 1951.

Thomas, H. Rex, Jorgensen, Hans & Wester, R. E. Resistance to downy mildew in lima bean, and its inheritance. Phytopathology **42**: 43–45. Ja 1952.

True, R. P. Oak wilt found in West Virginia. Castanea **16**: 115, 116. S 1951.

Valleau, W. D. The evolution of susceptibility to tobacco mosaic in *Nicotiana* and the origin of the tobacco mosaic virus. Phytopathology **42**: 40–42. Ja 1952.

Wiles, A. B. & Walker, J. C. The relation of *Pseudomonas lachrymans* to cucumber fruits and seeds. Phytopathology **41**: 1059–1064. D 1951.

Zentmyer, George A. & Richards, Sterling J. Pathogenicity of *Phytophthora cinnamomi* to avocado trees, and the effect of irrigation on disease development. Phytopathology **42**: 35–37. Ja 1952.

GENERAL BOTANY

(including Biography)

Allard, H. A. Drying herbarium specimens slowly or rapidly. Castanea **16**: 129–134. D 1951.

Brown, Babette I. Botanizing in the Olympic Rain Forest. Wild Flower **27**: 78–92. O 1951.

Camp, W. H. On the proposed check list of southeastern plants. Castanea **16**: 112–115. S 1951.

Constance, Lincoln. The versatile taxonomist. Brittonia **7**: 225–231. 10 D 1951.

Core, Earl L. Danske Dandridge. Castanea **16**: 138–140. D 1951.

Correll, Donovan S. With Fernald and Long in southeastern Virginia. Castanea **16**: 117–125. D 1951.

Gentry, Howard Scott. The belt plant press. Bull. Torrey Club **79**: 84–86. Ja-F 1952.

Graustein, Jeannette E. Nuttall's travels into the old northwest. Chron. Bot. **14**: 1–88. *illust.* Autumn 1951 [Ja 1952].

Howard, Richard A. The Society of Plant Taxonomists' plaque honoring Erick L. Ekman. Bull. Torrey Club **79**: 80–84. Ja-F 1952.

Jennings, O. E. Warren R. Witz. Castanea **16**: 142, 143. D 1951.

Ponce de León y Aymé, Antonio. Nociones de botánica sistemática I–III. Revista Soc. Cub. Bot. **8**: 23–40. Ja-S 1951.

Rollins, Reed C. Taxonomy today and tomorrow. Rhodora **54**: 1–19. Ja 1952.

Schiemann, Elisabeth. New results on the history of cultivated cereals. Heredity **5**: 305–320. D 1951.

Shull, G. H. Erich von Tschermak-Seysenegg. Genetics **37**: 1–7. *port.* Ja. 1952.

Simpson, George Gaylord. The species concept. Evolution **5**: 285–298. 31 D 1951.

Stebbins, G. Ledyard. Natural selection and the differentiation of angiosperm families. Evolution **5**: 299–324. 31 D 1951.

MAXIMUM STORAGE

Lane Herbarium Case
The Accepted Standard for general use

Lane HERBARIUM CASES

NOW IN USE IN OVER 115 UNIVERSITIES, BOTANICAL GARDENS, NATIONAL PARKS, ETC. since their introduction!

SPECIFICATIONS

STANDARD HERBARIUM
84 1/8" High, 27-13/16" Wide, 18-25/32" Deep

JUNIOR MODEL HERBARIUM
40" High, 27-13/16" Wide, 18-25/32" Deep

SOME USERS OF LANE HERBARIUM CASES

New York Botanical Gardens
Abilene Christian College
Agricultural & Mechanical College of Texas
Duquesne University
Florida State University
Georgia Teachers College
Louisiana Polytechnic Institute
Loyola University
Oklahoma Agricultural & Mechanical College
Southern Methodist University
State College of Washington
Tulane University
University of Alabama
University of Arizona
University of Arkansas
University of Chattanooga
University of Massachusetts
University of Idaho
University of Nevada
University of Texas
University of Wisconsin
Washington University
Yale University
Grand Canyon National Park
Olympic National Park
Hawaii National Park
Glacier National Park
Canisius College
Catholic University of Washington
Carleton College
Emory University
U. S. Dept. of Agriculture
Oregon State College
Riverside Municipal Museum
Rutgers University